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KEY TO PRONUNCIATION.

ä	far, father
ā	fate, hate
a or ă	at, fat
ã	air, care
ạ	ado, sofa
â	all, fall
ch	choose, church
ē	eel, we
e or ĕ	bed, end
ė	her, over: also Fr. *e*, as in *de; eu*, as in *neuf;* and *oeu*, as in *boeuf, coeur;* Ger. *ö* (or *oe*), as in *ökonomie.*
ẹ	befall, elope
ë	agent, trident
ff	off, trough
g	gas, get
gw	anguish, guava
h	hat, hot
h or ʜ	Ger. *ch*, as in *nicht, wacht*
hw	what
ī	file, ice
i or ĭ	him, it
ị	between e and i, mostly in Oriental final syllables, as, Ferid-ud-din
j	gem, genius
kw	quaint, quite
ṅ	Fr. nasal *m* or *n*, as in *embonpoint, Jean, temps*

ñ	Span. *ñ*, as in *cañon* (căn′yŏn), *piñon* (pēn′yŏn)
ŋg	mingle, singing
nk	bank, ink
ō	no, open
o or ŏ	not, on
ô	corn, nor
ȯ	atom, symbol
ọ	book, look
oi	oil, soil; also Ger. *eu*, as in *beutel*
ö or oo	fool, rule
ou or ow	allow, bowsprit
s	satisfy, sauce
sh	show, sure
th	thick, thin
ŧh	father, thither
ū	mute, use
u or ŭ	but, us
u̇	pull, put
ü	between u and e, as in Fr. *sur*, Ger. *Müller*
v	of, very
y	(consonantal) yes, young
z	pleasant, rose
zh	azure, pleasure

′ (prime), ″ (secondary) accents, to indicate syllabic stress

THE AMERICANA

Potts'town, Pa., borough, Montgomery County; on the Schuylkill River, and on the Pennsylvania and Philadelphia & R. R.R.'s; 35 miles northwest of Philadelphia. It was laid out as a town in 1752, and was at first named Pottsgrove; in 1815 it was incorporated as a borough and named Pottstown; the size of the borough was increased in 1888. It is the trade centre of a fertile agricultural region; and there is also a considerable amount of mineral wealth in the vicinity. The borough is noted for its manufactures of iron and steel; it contains rolling mills, blast furnaces, steel mills, bridge works, boiler works, nail factories and manufactories of agricultural implements, also cigar factories, carriage works, planing mills, and creameries. It has a public high school and school library, and is also the seat of the Pottstown Business College, and of the Hill School, a private non-sectarian secondary school for boys. Pop. (1910) 15,599.

Potts'ville, Pa., borough, county seat of Schuylkill County; on the Schuylkill River near its source, and on the Pennsylvania, the Lehigh V., and the Philadelphia & R., and the Central of N. J. R.R.'s; 75 miles northwest of Philadelphia. It was first settled in 1800, was incorporated in 1828, and made the county-seat in 1851. It is situated among the Schuylkill anthracite coal fields, and is one of the most important mining centres and shipping points of the region. Its manufacturing interests are also of importance; they include steel mills, blast-furnaces, rolling mills, and foundries; also planing mills, cotton-velvet, and silk mills. It was in Pottsville that anthracite coal was first successfully used in smelting iron ore. Among its more important buildings are the county court-house and jail, a public hospital and the Pottsville Athenæum. The Athenæum contains a library, and the borough also has a public school library and the county law library. There are a public high school, two Roman Catholic parish schools, and the Commercial Union School. The chief executive officer of the borough is a burgess, who holds office for three years; the legislative body is a borough council, which also has power to appoint many of the city officers; the city auditor, city treasurer and the school directors are elected by the people. Pop. (1910) 20,236.

Pottsville Conglomerate, the name by which the millstone-grit at the base of the coal measures is generally known in Pennsylvania, because it has its greatest development at Pottsville, near the eastern edge of the anthracite fields. It is there more than a thousand feet thick, but toward the west and north grows thinner. The rock is composed of sand and pebbles, chiefly of quartz, giving it considerable hardness.

Potvin, pō-văn, **Charles,** Belgian author: b. Mons, Belgium, 2 Dec. 1818; d. Ixelles 1 March 1902. He was educated in the Catholic University at Louvain, became professor of national literature at Brussels, in 1883 conservator of the Wiertz Museum there, and in 1881 a member of the Belgian Academy. He was editor of 'La Nation' in 1850–3, and in 1862 became editor of the 'Revue de Belgique.' His writings comprise volumes of verse and criticism, including: 'Marbres Antiques et Crayons Modernes' (1862); 'Jacques d'Artevelde' (1861); 'L'Histoire des Lettres en Belgique' (1882), and 'L'Art Grec' (1895).

Pouched Dog. See DASYURE.

Poughkeepsie, pō-kĭp'sĭ, N. Y., city, county-seat of Dutchess County; on the east bank of the Hudson River, and on the New York C. & H. R. and the Central N. E. R.R.'s; about 70 miles north of New York city. It has regular steamer connections with all the Hudson River ports, and a bridge spanning the Hudson at this point connects the city with the West Shore Railroad on the west side of the river. Electric lines connect the city with cities and towns on both sides of the Hudson. Part of the city is on a plateau extending back from the river, and part of it is on the slope to the river.

It was settled about 1698 by the Dutch. On the same site there had been an Indian village called Apokeepsing, meaning «safe harbor.» It was the capital of the State during the Revolutionary War. The State convention which ratified the National Constitution met here in 1788. Alexander Hamilton was one of the leading members of the convention. In 1799 the village was incorporated and in 1854 it was chartered as a city. The cantilever bridge, which was opened in 1889, cost about $5,000,000. Its length is 7,100 feet, it has three cantilevers, and rests on six massive piers. The chief industrial establishments are foundries, machine shops, lumber mills, cooperages, mowing machine works, shoe factory, cigar factories, patent medicine works, breweries, and flour mills. Two miles north of the city is the Hudson River State Hospital for the Insane, and in the city is Saint Barnabas Hospital, a Home for Old Ladies, Home for Old Men, and a Home for the Friendless. East of the city is Vassar College (q.v.). The educational institutions of the city are the Eastman Business College, Berkely School for boys, Lyndon Hall School for girls, Riverview Military Academy, a high school, public and parish graded schools, the Adriance Memorial Library, containing 25,000 volumes, and the libraries connected with several of the schools. The Vassar Brothers Institute is one of the fine buildings of the city. College Hill Park has an area of 100 acres. There are several fine church buildings. The revised charter of 1900 provides for a mayor, who holds office two years, and a council. The city owns and operates the waterworks. Pop. (1910) 24,936.

Poultney, pōlt'nĭ, Vt., town, Rutland County; on the Poultney River, and Lake St. Catherine, and on the Delaware & Hudson railroad, 18 miles southwest of Rutland. It is in an agricultural region; slate is quarried in the town and vicinity, and there are slate manufactures, a foundry and machine shops. It is situated in a picturesque country in the Green

Mountains, the lake affords facilities for boating and fishing; consequently the town has become popular as a summer resort, and contains several hotels. It has a public high school established in 1887, and is also the seat of the Troy Conference Academy, a coeducational secondary school. Pop. (1910) 1,474.

Poulton, powl'tŏn, **Edward Bagnall**, English scientist: b. Reading, Berkshire, 27 Jan. 1856. He was educated at Oxford and was demonstrator in the anatomical department of the University Museum 1877–9, and lecturer in natural science at Keble College 1880–9, as well as at Jesus College 1880–8. In 1889 he became a fellow of the Royal Society and since 1893 has been university professor of zoology at Oxford. He delivered a course of lectures before the Lowell Institute, Boston, Mass., in 1894 on 'The Meaning and Use of Colors in Animals.' He is the author of 'The Colors of Animals' (1890); 'Charles Darwin on the Theory of Natural Selection' (1896).

Poultry, a term designating collectively all birds which have been domesticated for their flesh or eggs, including fowls, ducks, geese, turkeys, guinea fowls, peacocks and pigeons. The word "fowl" once included game-birds, but now applies only to the domestic kinds and includes fowls, turkeys, guineas and all of the great family *Phasianidæ*. Pheasants, however, belong to a smaller genus, *Phasianus*, which though kept in captivity are not readily domesticated.

Origin.— The common fowl which makes up the largest class of domestic poultry is supposed to have originated in western Asia. Darwin believed all domestic fowl to have sprung from a single species, the jungle-cock (*Gallus bankiva*), which still is found in the jungles of India in the wild state. His belief was founded upon the facts that *G. bankiva* closely resembled the black-breasted red game of to-day, one of the oldest varieties of domestic fowl known; that it crosses readily with the common hen, producing fertile offspring; that it resembles domestic fowl in voice and action; that it is readily domesticated, and that according to his observation it produced fertile offspring when crossed with other species of wildfowl, and that sterile offspring resulted when other wild species were crossed with domestic fowl. On this latter point it is believed that Darwin was in error, and that many varieties of common fowl have descended from several wild species and their crosses. In support of this belief it is known that several domestic varieties bear a much closer resemblance to other wild species than they do to *G. bankiva*. The Oriental games, for example, resemble *G. giganteus* much more closely than they do *G. bankiva;* indeed the *G. giganteus* kept in domestication by the natives of the Malay Peninsula at the present time are so like the Malay breed of our domestic fowl that they might be considered the same. Among the wild fowl now in existence which may have contributed largely or in slight degree to the foundation of the common fowl are *G. bankiva* (or *G. ferrugineus*) from southern India only; *G. sonneratii*, found in Hindustan; *G. furcatus* from Java; *G. stanleyi* from Ceylon; *G. giganteus*, the Kulm fowl of the Malay Peninsula; and others not so well known.

The characteristics of the domestic fowl are as follows: Beak heavy; gullet enlarged to form a crop; small stomach; gizzard strong to crush hard seed; two long feet (sæca) adapted to scratching, running and perching; wings not suited to long flight; gregarious, polygamous, domestic in the extreme; prolific; period of incubation 21 days; young covered with down and able to run about as soon as hatched; brave in defense; flesh and eggs prized as human food.

History.— Fowls are the oldest of our domesticated animals, so far as history records. The earliest record is to be found in a Chinese encyclopædia compiled from ancient documents, where it says "fowls are creatures of the west." Fowls were introduced into China in a dynasty 1400 years B.C., and the Chinese considered the Indian region as their source. They were also mentioned by Aristophanes between 400 and 500 B.C., and, it is said, are figured on Babylonian cylinders between the 6th and 7th centuries B.C. Mention of fowls is also made in the writings of the Greek and Roman authors Theognis, Aristotle, Diodorus, Æschylus, Plutarch, Plato, and Pliny, and are supposed to have been taken into the British Isles by the Romans, who regarded them as sacred to Mars. The cock has in all ages occupied an exalted position as an emblem symbolizing courage among the ancient Gauls and afterward among the French, who used it on their ensign after the Revolution. It figures also in the Bible and has been used in Christian art to symbolize the Resurrection. At the present day it is regarded as a herald of victory.

Extent and Importance of the Poultry Industry.— Poultry husbandry is an old art and a new science, for it is only within the present century that special attention has been given to raising poultry as a commercial enterprise; and only since about 1880 has any real effort been made to classify the information on the subject into anything like a science. The explanation of this advance may be found first in the fact that this class of domestic animals supply human food, second in importance and value only to the dairy products. The egg offers the most digestible form of meat known, and one which can be cooked in the greatest number of attractive ways, and the flesh forms an article of diet universally prized. The second reason is found in the fact that poultry, particularly fowls and pigeons, are variable and plastic in the hands of the breeder, and can be rapidly and skilfully made to acquire new forms and colors. In no branch of animal husbandry have so striking results been accomplished as in poultry-breeding. Observe the large number of varieties at the present time, and note the contrast between the mammoth Brahma weighing 12 pounds, and the diminutive Bantam of the same name weighing 20 ounces; the brilliantly spangled Hamburg and the sombre Orpington; the long tail of the Yokohama and the cushion-tail of the Cochin; the clean close feathering of the Indian game, and the abundant fluffy feathering of the Asiatics; the smooth shanks of the Plymouth Rock and the feathered shanks of the Langshan; the great prolificacy of the sprightly Leghorn, and the large solid muscle of the unproductive, clumsy Indian game. Also note the great variety in plumage both in color and in form, the spangled, laced, penciled, striped, barred, or solid-colored feathers, ragged in the frizzles and downy in the silky; varieties of fowls with eyes varying in color from black, to pearl, bay or gray; fowls with rose combs, leaf comb, single or pea comb, and fowls with or without beards and crests, and showing in their plumage every color of the spectrum. Then realize that all these have been produced within the history of man from a single or at most a few wild species of jungle-fowl. Moreover, all these (more than 100 varieties) breed true with a potency that is remarkable.

The following figures show the recent growth of the poultry industry in the United States: In 1879 the number of «barnyard fowl» was 102,272,135; in 1889, 258,871,125. In 1879, the product was 456,910,916 dozens of eggs; in 1889, 819,722,916 dozens; in 1899, 1,293,818,144 dozens. In 1895—2,282,414 cases of 30 dozen eggs each were received in New York city; in 1896—2,594,894 cases; in 1897, 2,751,833; and in 1898—2,709,880 cases. In 1900 the value of poultry in the United States was $136,891,877. The value of eggs in one year was $144,286,370. There are 5,739,000 farms in the United States containing 250,681,593 chickens, ducks, turkeys and geese more than three months old, or 42 head of fowls to each farm, worth $70,000,000. There are now about 350,000,000 old and young chickens, ducks, geese, turkeys, and other domestic fowls on American farms producing yearly for market $150,000,000 worth of poultry and $225,000,000 worth of eggs. About a third as much more is consumed at home, making a total valuation of $500,000,000.

VALUE OF EGGS PRODUCED IN THE 10 BEST STATES.

1. Iowa	99,621,920	dozen	at	10 c....	$10,016,707
2. Ohio	91,766,630	"	"	11.1c....	10,280,769
3. Illinois	86,402,670	"	"	10.3c....	8,942,401
4. Missouri ...	85,203,290	"	"	9.8c....	8,315,371
5. Kansas	73,190,590	"	"	9.9c....	7,237,111
6. Indiana	70,782,200	"	"	10.5c....	7,441,944
7. Penna	67,038,180	"	"	13.5c....	9,080,725
8. New York..	62,096,690	"	"	13.8c....	8,630,062

Poultry and eggs form 16.3 per cent of all animal products produced in the United States, being greater in value than any except dairy products, including milk, butter and cheese, and all animals sold or slaughtered. The poultry and eggs sold in the United States in one year is worth $189,731,370 more than the wool product. The poultry and egg product of 1899 exceeded in value the wheat crop of 28 states and territories. The eggs marketed in one year in the United States are of more money value than all the gold and silver mined in a year, and the same is true of the value of the poultry output. The number of eggs produced per capita are 203 valued at $1.89. The average price per dozen for eggs throughout the United States is 11.15 cents. It is estimated that in New York city the average egg consumption is nearly one egg per day for each inhabitant.

More than 50 poultry papers are published in the United States, several of which report circulations of 30,000 to 50,000 copies to each issue. In addition to this nearly all agricultural and live-stock papers conduct poultry departments. In order to hatch the billions of chickens produced each year more than 50 kinds of incubators are manufactured in the United States, which leads all nations in this field of inventive skill. In 1890 a 500-hen poultry farm was an object of wonder, but now there are thousands of poultry plants having 1,000 hens and many which have 2,000 to 3,000 or more, besides broiler and squab-duck establishments which turn out more than 50,000 per year. Nevertheless, out of 62 State agricultural colleges in the United States only 10 offered in 1904 poultry instruction in any form. To Cornell University is due the credit of giving the first regular course of poultry instruction in the United States, which occurred in the winter of 1891. At Kingston, R. I., was opened in 1898 the first poultry school, where students could devote several weeks (six) to the study of poultry. Of the agricultural experiment stations in the United States only six have made any adequate provision for investigation.

Poultry Keeping.— Successful poultry keeping depends upon five factors:

First, a location in proximity to good markets, with access to cheap grain and having a rich, well drained soil, temperate climate, and sheltered situation.

Second, suitable buildings. These should be warm in winter, cool in summer, light and dry at all times. There should be about six square feet of floor-space per hen, six to eight cubic feet of air-space to each pound live weight, one square foot of glass surface to twelve square feet of floor surface; and each hen should have from 150 to 200 square feet of grass-covered yard. Allow six to eight inches perch room for small breeds, eight to ten inches for medium sized breeds, ten to twelve inches for large breeds. Every house should have a dust-box containing sifted coal-ashes and land plaster; and darkened nests, one foot square, and six inches deep.

Third, the right kind of food skilfully fed. Fowls are natural grain eaters, great insect hunters, and to a large extent grazers, therefore they should be fed a good variety of grains, an abundance of meat and plenty of green food. The fowl not having teeth must be supplied with grit for grinding. This should include both cracked oyster shell, and hard, cracked, flinty rock. The ration best suited to egg-production should contain digestible nutrients in a ratio of one pound protein to about five pounds carbo-hydrates, and should be so fed that the appetite will be kept good. Fowls should become neither very fat nor very poor. The best laying hen is the one that is in the best physical vigor. In this condition she will have a little surplus fat in her body. A good ration for egg-production is to feed night and morning a mixture of whole grain, consisting of about equal parts by weight of corn, wheat and oats, feeding more of the two latter in proportion at the morning meal which should be light, only enough to keep the fowls busy. At night they should have all they can eat. At noon feed what they will eat up clean within a few minutes of a meal mixture containing equal parts by weight of wheat bran, wheat middlings, corn meal, ground oats and meat scraps, mixed with cooked turnips and little potatoes and about five per cent of cut clover hay. Skimmed milk should be used to scald this feed if possible. Plenty of water and fresh vegetables should always be kept accessible.

Fourth, good fowls carefully bred. There are great differences between varieties of fowls and also between individuals of the same strain. It has been found by trap-nest records that a hen has laid 251 eggs per year, while the average of a good many flocks laid only about 140 eggs per year, and several fowls were wholly unproductive. There is also great difference in the rapidity of growth, shape of body and quality of flesh of individuals. Therefore a rigid selection of the very best to breed from should be practised. It will pay to keep pure-bred chickens because they are more uniform in size, shape and color, which makes them more attractive to sell, more alike in habits and characteristics, and this will result in greater production and better health. Their eggs hatch more satisfactorily because similar in size, shape and texture, and will bring higher prices. A good working rule in making breeding hens is to allow one male for 25 hens of the Mediterranean breeds; one male to 15 or 20 hens of the American breeds; one male to 8 to 10 of the Asiatic breeds. The proportion will vary, however, according to the power of individuals.

COMPOSITION OF EGGS AND POULTRY.

	Water	Ash	Protein	Fat
Hen	55.8	3.8	21.6	17
Pullet	55.4	3.4	21.2	18
Capon	21.6	3.7	19.4	33.9
Fresh egg	65.7	12.2	11.4	8.9

Fifth, ability to hatch and rear chickens. To grow chickens successfully six things should be observed,— keep them warm, dry, clean, busy and hungry, and keep them growing. Feed a ration of bread and milk and boiled egg for the first few days, then add a mixture of several small or cracked grains, including hulled oats, wheat, corn, millet, sorghum seed, Kafir corn and about one fifth by weight of the best meat scraps with plenty of skimmed milk to drink.

Varieties of Fowls.— There are more than 110 varieties of domestic fowl that breed true and are well known in the United States at the present time. Of these, 96 varieties, including bantams, are recognized by the American Poultry Association as standard-bred. In addition to these many well established varieties exist in other countries. All the standard-bred fowls are grouped into eleven great classes by the official poultry publication, 'The American Standard of Perfection.' This classification of breeds is based on similarity of characteristics, on blood relationship, and on place of origin:

American Class.— This is the largest class in the 'Standard.' It has five breeds divided into fourteen varieties: (1) Barred, white and buff Plymouth Rocks; (2) silver, golden, white, buff, partridge, black and silver-penciled Wyandottes; (3) black and mottled Javas; (4) American Dominiques; (5) Buff Orpington. With the exception of the Orpington the whole American class of fowls has been originated in the United States, and all are of composite blood, and combine to a high degree egg-producing, flesh-making and maternal qualities. They are medium to large in size, compact and meaty, extremely hardy; good layers of medium-sized, dark to light-brown eggs; careful mothers; fairly active. Their shanks are smooth and the skin is yellow, except in the case of black Wyandottes, Javas which have dark shanks, and Orpingtons which have white shanks. All have red earlobes. The Plymouth Rocks all have medium sized single combs and rich bay eyes. The Wyandottes have rose combs with a spike following the shape of the head, and bright bay eyes. The Javas have small single combs, and the Dominiques a rose comb. The buff Orpingtons are the largest, the cock weighing 10½ pounds, the hen 8½. The Plymouth Rock and Java come next, the cock weighing 9½, the hen 7½, while the Wyandotte and Dominique weigh,— cock 8½, hen 6½.

The barred Plymouth Rocks are perhaps the most popular fowls in America. Their origin, like that of most of the domestic breeds, is disputed and obscure. They were first brought to public notice in Massachusetts in 1850 or Connecticut in 1860, and are thought to have been derived from a cross between the American Dominique and the black Java; others assert that they were the result of a cross between a common hawk-colored male and a black Cochin hen. It is most likely that the barred Plymouth Rock contains the blood of several varieties, and is due to man's good sense in seizing upon a happy accidental combination of size, form, color, hardiness, maternal qualities and general excellence rarely equaled, followed up by a systematic effort to produce the particular type found in the barred Plymouth Rock and which up to that time was possessed by no other breed. White Plymouth Rocks originated in Maine in 1873, and were admitted to the 'Standard' in 1888. They are said to be a sport from the barred Rocks. That a white Leghorn cross was used in their development is also certain. Buff Plymouth Rocks were admitted to the 'Standard' in 1893. They are supposed to be the result of a cross between buff Cochin and barred Rocks, yet good authorities claim that they have no Plymouth Rock blood in their makeup. They are prolific, grow well, have a popular color and are gaining rapidly in public favor.

Wyandottes are a valuable breed, the first variety of which was the silver Wyandotte, which originated in 1868 in New York State and was admitted to the 'Standard' in 1883; it was the result of a cross between silver Sebrights and buff Shanghais, or silver-spangled Hamburgs and dark Brahmas or Cochins. They are small-boned, full-breasted, plump, meaty, and quick to mature, about a pound lighter, and laying smaller eggs than Plymouth Rocks. Golden Wyandottes originated in Wisconsin, in 1881, and admitted to the 'Standard' in 1888, were formed by crossing pea-comb partridge Cochins and single-comb brown Leghorns, or else by crossing buff Cochins and golden Sebrights. The white Wyandotte is the most popular variety of all the Wyandotte family. It is supposed to have begun in a sport from the silver Wyandottes, or by a cross between silver Wyandotte and rose-comb white Leghorn. This variety is a close rival to the barred Plymouth Rock for first place as the most useful fowl in America, and has the advantage of white plumage, which is important for market poultry. Black Wyandottes are a sport from the silvers; and buff Wyandottes are becoming popular.

Asiatic Class.— This class consists of three breeds, embracing eight varieties, as follows: (1) light and dark Brahmas; (2) buff, partridge, white and black Cochins; (3) black and white Langshans. As a class these are meat fowls, and are the heaviest fowls known, the light Brahma being the largest cock, 12 pounds, hen, 10 pounds; Cochin cock, 11 pounds, hen 8½;

Langshan, cock, 10; hen, 7. They are rather poor layers, producing small to medium brown eggs. They are hardy, excellent mothers, although inclined to be too broody, and of kind disposition; shanks and toes heavily feathered, skin yellow, heavily feathered, ear-lobes red, combs medium, single in Cochins and Langshans and pea-comb in Brahmas. The light Brahma is most popular as a meat fowl, and the Cochin for exhibition purposes. Cochins were introduced into England from China in 1843, as Shanghais or Cochin Chinas. They were of many types and colors, very large and awkward. Brahmas are said to come from native Malayan sources, but it is more likely that they were improved from the old Shanghai fowl. The Langshans represent a valuable but not very popular breed from North China, introduced into England in 1872 and admitted to the ‘Standard’ in 1883. They lay very dark-shelled eggs, have black shanks and pink skin, and are the most active and least broody of the Asiatic class.

Mediterranean Class.— This large and popular class consists of five breeds divided into twelve varieties, and are more widely distributed throughout the world than any other family of poultry. The breeds are: (1) Single-comb brown, rose-comb brown, single-comb white, rose-comb white, black, buff, and silver duck-wing Leghorns; (2) mottled Anconas; (3) white and black Minorcas; (4) blue Andalusians; (5) black Spanish. As a class they are noted for their activity, egg-producing and non-sitting qualities and for their early maturity; they are medium to large in size, the Minorcas and black Spanish weighing,— cock, 8 pounds, hen, 6½; blue Andalusians,— cock, 6½, hen, 5½; the Leghorns and Anconas should weigh about 6 pounds for cock and 4½ for hen. Hens of this class lay medium to large pure white eggs and are poor sitters and unreliable mothers. All have smooth shanks and single combs except the two rose-combed varieties; and all have white ear-lobes. Though originally from a warm country about the Mediterranean, and although they have large combs and close feathering, they prove remarkably hardy and prolific in northern climates.

Among Leghorns the brown variety is perhaps more uniform in type than any other, but not so uniform in color. White Leghorns are supposed to be a sport from one of the other Leghorns. They are larger than the brown, lay larger eggs that are a little whiter, and are the most popular laying fowl in the world. Black Leghorns are a variety imported from Italy in 1872 and admitted to the ‘Standard’ in 1876. They are a pure variety of long standing, popular in England and Switzerland, where they are called Italians, but their color makes them unpopular in America. Buff Leghorns are gaining rapidly in favor, but as yet the variety is not thoroughly fixed as to type or color, although it is recognized by the ‘Standard’ and has made great progress. Silver duck-wing Leghorns are little bred, and are kept mostly for their beauty and for exhibition.

Black Spanish is one of the oldest breeds known, and derived from Spain. Columella wrote about them nearly 2,000 years ago, and they were bred pure in England before either Cochins or Brahmas. Their value is principally ornamental, and they are rather delicate.

Minorcas probably came from the Island of Minorca in the Mediterranean, and are supposed to have descended from the black Spanish, which they much resemble, although larger and without the white face. They were imported to the United States in 1880. They are larger than Leghorns, slower to mature, and are conspicuous because of their brilliant, green-black plumage, large red single combs, long straight backs and deep bodies. Their eggs are snow-white and larger than those of any other kind of chicken.

Polish Class.— This family consists of one breed, having eight varieties, namely: White-crested black, golden, silver, white, bearded golden, bearded silver, bearded white, and buff laced. They are medium in size, good layers of white eggs, and non-sitters. All have large, showy crests, owing to which they fall easy victims to hawks and enemies. They have in some cases beards; small V-shaped combs, and slate or willow shanks. As they are chiefly ornamental, they are not popular in the United States.

Hamburg Class.— This is a Dutch family, small, active and prolific, with rose-combs with a spike turned slightly upward. They are unreliable sitters and mothers, and lay small white eggs. Two breeds are recognized, in eight varieties,— gold-spangled, silver-spangled, golden, silver and white penciled, and black Hamburgs, and Red-caps.

Red-caps are noted for their beauty, conspicuous red combs, red ear lobes and spangled plumage. They are delicate and in most respects resemble Hamburgs.

French Class.— Three breeds: (1) Houdan; (2) La Fleche; (3) Creve-cœur. This class may be described as composed of ornamental table fowls, and the Houdan is the only variety at all common in the United States, for as a rule they do not prove hardy in this climate. All are fairly good layers of medium-sized, white eggs, and are non-sitters. All have large crests, light skin and shanks, and five toes on each foot.

English Class.— The Dorkings, white, silver and gray, are, first of all, meat fowls, although also fair layers of large white eggs. They are robust in form and compact in flesh. In the United States they are delicate, the fact that they have five toes is a disadvantage; and the pale skin and shanks so much prized on all English and French breeds are decidedly objectionable in the United States.

Game Class.— The games are supposed to be the oldest of all domestic fowl. They were originally kept for fighting. Now they are largely bred for exhibition purposes, and are divided into two families: pit games and exhibition games. All are brave and cruel. Their flesh is extremely solid and fine grain, and their plumage close and scanty. For the most part they are only fair layers of dull-white, small to medium, globular eggs. They are excellent mothers. Every variety of exhibition game is represented in the bantams. The following varieties are recognized as standard-bred: black-breasted red, brown red, golden duck-wing, silver duck-wing, red pile, white, black, and birchen.

Five varieties are grouped as Oriental games, containing four breeds as follows: Cornish and white, Indian game, black-breasted red

Malay, black Sumatra, black-breasted red Malay bantam. The characteristics of this class are large size, coarse flesh, cruel disposition (although they are poor fighters) and unsatisfactory laying qualities, although they make good mothers; all have yellow skin and shanks.

Bantams other than Games.—This class comprises 16 varieties grouped under 7 breeds, namely: golden and silver Sebright; white and black rose-combed bantam; white-booted bantam; light and dark Brahma; buff, partridge, white, and black Cochin; black-tailed, white and black Japanese; white-crested white, and buff-laced Polish, and many other varieties not admitted to the 'Standard.'

Miscellaneous.—Among the miscellaneous breeds not otherwise classified there are:

(1) Silkies, an old and very beautiful breed that have been bred wholly without natural feathers, but with a beautiful downy, hair-like coat in two colors, black and white. (2) Frizzles, a breed that has its entire plumage ruffled and crumpled, turning in unnatural directions, and is kept only as an oddity. (3) Sultans, a very beautiful breed, valuable as a lawn fowl. They resemble Polish in most respects, except that they have feathered legs. Russians, Sumatras, and rumpless fowls are also in this class of oddities and ornamentals.

The breeds of fowl can be arbitrarily classified as to their utility characteristics, as follows:

Best Layers	*Best for Meat*	*Best General Purpose*
Leghorns	Indian Games	Plymouth Rocks
Hamburgs	Dorkings	Wyandottes
Minorcas	Brahmas	Rhode Island Reds
Houdans	La Fleche	Orpingtons

Best Mothers	*Poorest Mothers*	*Most Hardy*
Wyandottes	Leghorns	Plymouth Rocks
Plymouth Rocks	Minorcas	Leghorns
Games	Hamburgs	Games
Brahmas	Spanish	Wyandottes

Least Hardy		*Most Ornamental*	
Dorkings	Polish	Black Spanish	Silkies
Spanish	Hamburgs	Sultans	Yokohamas

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Poultry as an Industry. The information of the present article will be given under the following divisions: (1) The demand; (2) conditions of success; (3) details to be observed; (4) the necessary equipment; (5) the profit of the industry.

THE DEMAND.

There is a steady and constantly increasing demand for first-class poultry products, both in the form of eggs and poultry for the table, and when the production of either of these commodities is combined with pure-bred poultry the producer has a doubly assured and considerably increased income.

There is certainly no danger of over-stocking the market, provided the quality be first class. Statistics prove that the city of Greater New York consumes more eggs each year than the entire Empire State produces. The two States of New York and Pennsylvania consume five times as many eggs as they produce. The importation of poultry into these two States is even proportionately larger than that of eggs. The people who produce the choicest poultry for the tables of the more fastidious residents of our great Eastern cities realize prices more than double the average price of the average poultry products marketed in those same cities. The retail price of strictly first-class eggs during the fall and winter months is more than three times the average summer price of average eggs in those same markets. There is a constant demand at these high prices for a product that can be guaranteed strictly first class, while it is only the second-class or third-class products that are at any time a drag on the market. The people are being educated to the fact that there is a vast difference between fowls of the same age for table purposes, and that even fowls of the same variety and age vary largely in quality according to the methods by which they have been fatted and dressed.

CONDITIONS OF SUCCESS.

There are a few general principles, therefore, that he who hopes to succeed in the poultry business should become familiar with before embarking largely in this enterprise. 1. He must ever bear in mind that to acquire the greatest profit he must produce the finest quality. The market is generally glutted with the lower grades of poultry and eggs. These are supplied at an actual loss. 2. He must decide upon some one branch of the business which he will make his specialty, and, having made his decision, he must push that line to the limit, cultivating only as accessory the other minor branches of the industry. In making this decision he must give careful attention to his own adaptability to his chosen branch of the work, considering well his location and surroundings, his proximity to market, and the demands of that market. 3. He must be prepared to apply the business principles of the business man to the poultry industry. He must apply the principles of industry, thrift, and economy in poultry production with the same energy and persistence as they are practised in our great manufactories. In fact, he becomes a manufacturer, converting the raw materials of the farm crops into those finely finished products, eggs and poultry.

DETAILS TO BE OBSERVED.

Having decided, for example, that egg production for the city markets shall be his chief aim, he must proceed in building up his business with that particular object constantly in view. In this work the following hints will be useful:

1. *Selection of his Variety.*—He must keep but one variety, so that his eggs may be as nearly uniform in color and size as possible. Boston calls for a brown egg; New York prefers a white egg. Each city will pay a few cents per dozen more for eggs of its favorite color. The Asiatics — Brahmas and Cochins — and the Americans — Plymouth Rocks and Wyandottes — produce the brown eggs. The Mediterranean varieties — Leghorns, Minorcas, and Anconas — are the largest producers of the white eggs.

He must, however, in selecting his variety, remember that the Brahmas and Cochins will produce but few eggs until eight months old, while the Plymouth Rocks will lay at six months, and the Wyandottes and Leghorns at five months.

If he intends to grow his own young stock he must provide incubators and brooders for the non-sitting Mediterranean varieties, while the Asiatic and American varieties will hatch and rear their own young.

He must also calculate on building warmer and more comfortable houses for the Mediterraneans than will be necessary for the close-fitting rose-combs of the Wyandottes or the small pea-combs of most of the Asiatics. All the Mediterranean varieties have large combs and pendulous wattles, very susceptible to frost. The Plymouth Rocks, with their medium sized combs, come between the extremes described, in this particular.

The time of year when he stocks his plant will decide whether he shall start by purchasing eggs for hatching or shall purchase fowls for his foundation. If he begins in the spring, and is equipped with incubators for hatching — and few now depend exclusively on the hens for hatching and rearing — then he will start more cheaply by purchasing eggs from some reliable breeder of his chosen variety. In the fall of the year it is best to start by buying pullets then four to six months old and ready to begin producing eggs.

2. *Care of the Stock.*—No hen can be a profitable egg producer unless she is kept comfortable and happy. More poultry plants have been wrecked and abandoned because of neglect in caring for the fowls than by any other cause. The questions of food and shelter will be considered under those headings, so we shall content ourselves here with merely mentioning two items:

(*a*) *Cleanliness.*—The hen is not an exacting tenant but she is naturally rather fastidious about some things, and she has a right to be. She must have her bath, and that bath is not a water bath, but a dust bath in which she can wallow occasionally and sift her feathers full of fine dust. This looks to be dirty, but it is not; simply dusty. Her quarters, furthermore, must be frequently cleansed. All droppings should be removed from the dropping-board at least once each week, and a little sweetening of the surroundings by a liquid disinfectant and insecticide is most advisable. Fresh straw as a litter for the floor of the house should be provided occasionally, and the nests — the receptacles for those fresh eggs so susceptible to any taint — should be renewed with fresh material frequently.

(*b*) *Water.*—Since an egg is two thirds water, it seems useless to argue for a constant supply of pure, fresh water. If this is provided, a hen will drink 20 times a day. If it is not supplied, her natural thirst will compel her to drink from filthy pools wherever she can find them, even from the cow tracks in the mud of the barnyard. Is it strange that fastidious people are becoming so particular as to specify how the hens that produce their eggs shall be supplied with food and water?

3. *The Separation of the Sexes.*—This subject is attracting much attention of late, and properly. So soon as the cockerels can be determined from the pullets they should be separated. Both sexes develop much more satisfactorily when kept by themselves. The cocks should be removed from the yards at the close of the breeding season, say in June, not to return until January or February. This much for the best interests of the fowls themselves.

But it is for a better and more certain quality of the eggs that we urge a separation of the sexes. When a hen that has been mated produces an egg, that egg has been fertilized at a certain point in its passage down the oviduct. From the moment of said fertilization until it is deposited in the nest — under normal conditions about 12 hours — the heat of the hen's body has caused the process of incubation to progress. If some great excitement prevents the hen from depositing the egg until the next day, the egg shows bloody streaks. We have known eggs to be thus retained by the hen for 60 hours, so that at the time the egg was laid the heart beats of the embryo chick could be seen with the naked eye.

While the process of incubation practically ceases as soon as the freshly-laid egg reaches a temperature as low as 80°, yet succeeding hens coming on the nest, perhaps several of them the same day, each warm that fertile egg up above 90° and the process of incubation is resumed. Where eggs are gathered at irregular periods — too often only "every few days" — it can readily be seen that only absolutely infertile eggs, those laid by unmated hens, are safely fresh, and many institutions, and even private families, are now making their contracts for "virgin eggs."

On the other hand, eggs that are absolutely infertile may be kept in almost any temperature without spoiling. We have placed such eggs in an incubator and kept them there for three weeks at a temperature above 100° all the time, and at the end of that period amateurs could not distinguish them from fresh eggs. Only the infertile egg will bear transportation in warm weather, and only those who will take care to have such can hope to realize the highest prices.

4. *Poultry Diseases.*—This subject is now very properly attracting much attention in our agricultural colleges. All desire to be excused from eating the eggs of a diseased hen. One's comfort comes, however, in the fact that diseased hens do not lay many eggs. There is a further satisfaction in the knowledge that the much-talked-of fowl cholera is a rare disease. Only a very few well-authenticated outbreaks of this disease have occurred in this country. There are a few other diseases with somewhat similar symptoms that are frequently mistaken for cholera.

(*a*) *Diarrhœa and Dysentery.*—These diseases are both usually brought on by neglect in the matter of food and drink. Pure water is one of the first essentials, and the fowls usually having an unnatural thirst, the pure water is an easy medium for administering some of the simple remedies, such as the Douglass mixture or a little carbolic acid in the water. With brooder chicks many of these irregularities of the bowels are caused solely by extremes of heat and cold. Chicks under three weeks old will scarcely endure day and night extremes of more than 15 or 20 degrees without manifesting bowel trouble, however carefully they may be fed. With mature fowls in confinement, a failure on the part of the attendant to provide them with grit, gravel, oyster-shell, and broken bone is a fruitful cause of these two diseases. Sour and rancid food will also cause diarrhœa, while fowls nearby fed on sound grains will be free from it.

(*b*) *Roup.*—This is by far the most common disease to which our domestic fowls are subject. It is generally considered contagious, but the most careful experimenters have failed to identify the germ or to inoculate a well fowl from a diseased one. Still we advise caution, and recommend that affected birds be isolated. Roup being simply an aggravated cold which rapidly takes on the catarrhal form, prevention is most advisable. Under buildings we shall urge freedom from draughts and dampness, which are the most prolific causes. The bird taken in the early stages, kept warm and dry, fed liberally, and the throat and nasal passages sprayed with a weak solution of carbolic acid or an emulsion of unrefined petroleum, will generally recover. If he gets seriously ill, kill and bury him.

5. *The Kinds of Food.*—This is a subject on which volumes could be written. In brief, since analyses show that the egg and the body of the young bird are almost identical, we may conclude that the food that is best for egg production is almost the best also for the growing fowl. When the fowl is grown and is about ready to be fatted for market, then a different ration is best, as will be shown.

For either the growing chick or the egg-producing hen, in addition to the grits, bone, and shell already referred to, the best results are obtained by a liberal supply, in large variety of form, of the three following classifications of food:

(*a*) *The Grains.*—These are the natural food of our domestic fowls. They grow in such a variety in this country that there is no excuse for limiting our fowls to a scanty variety. Many erroneously suppose that what a hen picks up first is best for her. Throw down a few handfuls of corn, wheat, oats, and millet to a bunch of fowls and the corn will be taken first, the others in the order named. Notice that this is in the order of the size, instinct teaching them to take first that of which they can get the most in the shortest time. Now the corn is the grain that ordinarily should be fed the most sparingly. It is so rich in the carbonaceous, or fat-making, elements that it is neither a good egg-maker or a good flesh-producer. To feed to fowls thin in flesh or to feed on a very cold evening, to enable the fowls to keep up their temperature through a long night, corn is best.

Of all our grains we esteem oats the best. Fowls do not take so kindly to oats as to wheat which we rank as second. Use these two grains alternately. Do not mix your grains. Give them something different each time if possible. Kaffir corn is one of our very best poultry foods. Sorghum seed and broom-corn seed are very similar. Buckwheat and sunflower seed in moderate quantities are excellent. Never feed more grain than they will clean up in a few minutes, unless you bury it among the litter so that they must scratch and work for it. Better that your fowls be kept slightly hungry and in working condition than too fat.

There is not so much necessity for soft foods as most people imagine. With plenty of grit to do the grinding, fowls will do well a longer time on the grains fed whole than on any other rations. There are, however, two forms of the grains that we urge to be used freely, namely, common coarse bran constantly in boxes, dry, where the fowls, young and old, can get all they will eat of it, and ground oats. This last we like to feed mixed with bran for the middle-of-the-day feed — the only time we think it advisable to feed soft, wet food.

(*b*) *The Greens.*—The hen at liberty, or in a state of nature, in summer consumes a large quantity of green, succulent food — clover, white clover, alfalfa, lawn-grass, plantain, and a score of other forms of greenness will be found in her full crop as she comes up to the perch at night. On such a ration, together with the grains she picks up, she does her best at the egg-basket, or puts on good flesh the most rapidly. This should teach us, therefore, what to supply her in the cold weather if we wish her to do then the work of summer. We must supply these green things to her. Cabbages and mangel wurtzels, one each hung in her pen, are good. Clover and alfalfa, harvested before the stalks have become woody, cut into short lengths, steamed or wet with hot water, and then dried out in part with the bran or chopped oats — this is the most dependable of all green foods in winter.

(*c*) *The Meats.*—«As full as an egg is of meat» is an old-time proverb. The white of an egg is largely albumen, and this is best supplied to the laying hen in some form of meat. The hen at liberty gets many a bug and worm. The hen in confinement must have these supplied if she is to produce eggs. The growing and fattening fowl also needs the meat in some form.

Avoid as far as possible the meat-meals of the trade, of uncertain origin and quite likely to be adulterated. Use the coarse granulated beef-scraps whose contents can generally be discovered. These, having been prepared by steam cooking, keep well in any climate. Add to these an abundant supply of clean-cut bone and the combination is cheaper, richer, and better than even the ground bone obtained by grinding fresh bones secured from the butcher.

(*d*) *Fattening Fowls.*—Where it is desired to quickly finish either young or old birds for the market, the crate-fattening process has no equal. Two birds are confined to a slatted coop two feet each way, and, for convenience in handling the droppings, the bottoms are slatted also. The most successful food is some skim milk or buttermilk, thickened to the consistency of batter with finely ground and sifted oats.

Feed in a small trough in front of the coop all the birds will consume in 20 minutes, then remove the trough, returning it clean for the next feeding. Some give an occasional feed of grit and cut bone with advantage. Three weeks is as long as birds can be fed by this method; in that time many will gain 40 per cent some 50 per cent. The improvement in the quality of the flesh is as noticeable as is the increase in quantity. To advance a cockerel weighing 3½ pounds and worth 10 cents per pound, to one weighing 5 pounds, worth 15 cents per pound, in three weeks, at a food cost of 8 cents, is to almost double one's investment, and many are doing this very thing. The yellow-skinned bird takes on a quality of flesh well distributed and having the white skin and white flesh so much desired by epicures.

(*e*) *The Secret of Successful Feeding.*—To put it in a word, it is variety. Whether feeding for eggs or for growth, your aim must be to have the fowl consume and assimilate the largest possible quantity of food and then convert and manufacture this into eggs or flesh. With the hen as with the dairy cow, the individual with the best digestive apparatus is the one you can feed most profitably, and you must constantly cater to her appetite; when she gets tired of one thing, have something else more appetizing to tempt her to eat more of it.

THE NECESSARY EQUIPMENT.

(*a*) *Houses.*—We have already intimated that the houses must be clean and comfortable. In order to be comfortable they need not be made warm with artificial heat. Fowls will endure intense cold if it is dry cold. Their bodies generate enough heat, if properly conserved, to keep them comfortable through the danger period — the night time. In the day they should have an opportunity to exercise and make their blood circulate in scratching in the litter on the floor for their grain ration.

The simplest and best houses we have ever seen are 12 feet wide and of any length desired so as to be divided into compartments each 12 feet square. The rear posts are 4½ feet high, the front posts 5½ feet high, the rear rafter 9 feet long, and the front rafters 5 feet long. This makes a house low at the back and only 7 feet high at the apex of the rafters, which is about two thirds of the distance from the rear to the front.

When the rafters are set, sheeting boards are put on the back and roof lengthwise. Over these the best quality of three-ply tarred paper is placed, running from the ground at the rear to the front eaves. This, if treated to a coat of hot gas tar, twice the first year and once each vear thereafter, will last for a dozen years or more, and it will be a house "air-tight at the back." The front and ends may be covered with finished weather-boarding and painted, but if so the ends should be lined with the tarred paper.

Be sure that the house is only 4½ feet high at the back. Build the dropping-boards 3½ feet wide, exactly half way between the floor and the roof. Use 2 x 4-inch scantling, flat side up, and running lengthwise of the house, for perches. These, if placed 6 inches above the dropping-boards, will place your fowls at night 10 feet distant from the front or cold portion of the house and will give them a very limited space overhead, so the warmth of their bodies will not be scattered but will be retained where it will keep most combs from freezing in the coldest weather.

Put one window in the front of each compartment. Do not be too lavish of glass. It radiates the heat and makes the house cold at night. A window 2½ by 4½ feet is large enough. If hung on hinges, it serves as a door through which one can step out from each compartment into its corresponding yard in front. A small exit hole, 8 x 14 inches, in the front for the use of the fowls makes sufficient ventilation in winter. In April the glass hinged windows may be removed and replaced until November or later with wire-screening doors.

All nest boxes, feed boxes, etc., should be attached to the front and sides of each compartment, 1½ feet above the floor, so as to leave the entire floor area for scratching room for the fowls.

Each compartment being 12 x 12 feet, and each hen requiring a floor area of 6 square feet in order that she may have sufficient room for healthful exercise, it will be readily seen that 24 hens is the proper number of occupants for each compartment. A house of this kind, 120 feet long, divided into 10 compartments, holding 240 hens, should not cost more than $240, or $1 per hen. Do not be deluded into the idea of making the walls double and stuffing the space between with straw or sawdust. The thin walls, if made air-tight as directed, are better in every respect and the house will be dryer and more wholesome.

(*b*) *Incubators and Brooders.*—Better buy these from those who have learned how to make them. There are a dozen good incubators on the market. Purchase the one that seems to you simplest and best. After some experience you may learn to make large box brooders out of discarded piano boxes that will save you some money, and give greater area for the chicks than the brooders you buy. Those of the writer are 5½ x 5½ feet, 2 feet high at the back, 3½ feet high at the front, with a 2 x 3 feet window in the front. They are built on 12-inch plank set edgewise for a foundation, thus allowing room for the lamp-box underneath the back. When chicks no longer need artificial heat, the heating apparatus may be removed and this brooder used as a colony house for the youngsters until cold weather.

THE PROFIT OF THE INDUSTRY.

This must depend largely upon the intelligence, skill, energy, and location of the operator. On farms the cost of food does not exceed 75 cents per hen per year. Where everything is bought, in most localities it need not exceed $1 per hen. It is a poor class of hens that cannot be made to average 120 eggs each, and it is a poor manager, anywhere east of the Missouri River, who cannot realize 2 cents each for those eggs. Deducting food cost of $1, the returns for labor and investment are $1.40 per hen. Many are averaging 180 eggs per hen and receiving 2½ cents each for the eggs, which brings the income on the egg business up to $4.40 per hen.

The best poulterers are combining the branches of the industry by raising pure-bred birds of some variety popular and saleable. They sell most of their surplus eggs for hatching during February, March, April, and May, the price they realize varying with their reputations, from 5 cents to 50 cents per egg.

Their next sales are from the cull male birds of their early hatchings. These go for broilers, at from 35 to 75 cents each, from April to July. The early hatched chicks, at one pound each, bring more than those three times as large but later, in the Eastern cities.

The early hatched pullets become egg-producers by August and September, just in time to replace the hens that have quit laying on account of the moulting. The choicest of both sexes are reserved for breeding, show, or sale purposes, and bring fancy prices. It is no unusual return for such a fancier to have an income of from $5 to $10 for every hen that he starts the year with, before that year closes.

T. E. Orr,
Secretary of the American Poultry Association and Superintendent of Poultry at the Saint Louis Exposition.

Pounce (a corruption of *pumice*), gum sandarach or some other substance pounded and sifted very fine, to rub on paper in order to prevent ink from spreading on it. The best pounce for this purpose is ground cuttlefish bone. Pounce is also the term applied to charcoal dust enclosed in a piece of muslin, or some other open stuff, to be passed over holes pricked in a work, in order to mark the lines or designs on paper, silk, etc., placed underneath, which are to be afterward finished with a pen and ink, a needle, or the like; or to any other coloring matter prepared and used in a similar manner.

Pound, (1) an English weight of two different denominations, *avoirdupois* and *troy*. Since 1856 the legal original standard weight in Great Britain and her colonies has been the imperial pound avoirdupois, a cylindrical mass of platinum, grooved near the top and bearing the mark «P. S. 1844 1 lb.,» the two letters P. S. signifying «Parliamentary Standard.» The pound troy in Great Britain is defined as 5,760 grains and is divided into 12 ounces, being used almost entirely for measuring bullion; the pound avoirdupois contains 7,000 grains, divided into 16 ounces, and is used for all ordinary commodities. The imperial standard troy pound constructed in 1758 was the only legal original standard weight between the years 1824 and 1856, but previous to these years certain weights, both troy and avoirdupois, constructed in 1858 under Queen Elizabeth had been the standards. These standards were not very accurately constructed, and through constant use became worn, but the pound avoirdupois probably contained as much as 7,002 of our present grains, while the pound troy weighed 5,759 grains. In the United States the British imperial pound avoirdupois has been copied to a great extent, but in theory the pound avoirdupois of Elizabeth is legal in this country. Edward III., from evidence in the official records, made the pound avoirdupois the standard, and Elizabeth probably copied her standard from his 56-pound weight, although standards had existed since 1497. The troy pound derives its name from the city of Troyes, where it was used as the standard of weight in the fairs held in that city. In 1497 it was made the legal weight for gold and silver and some authorities claim it was also used for bread, being known as the «old commercial weight of England,» and containing 7,600 grains. This troy pound displaced the monetary pound which had been in use from the times of the Saxons, and which contained 5,400 or 5,420 grains and was divided into 12 ounces or 20 shillings. At about the same time the merchant's pound containing 6,775 grains, divided into 15 ounces, came into considerable use. (2) Pound is also the highest monetary denomination used in British accounts, being equivalent to 20 shillings or 240 pence, and originally to a pound weight of silver (or of the alloy used). In the use of pound as designating money, the epithet *sterling* is generally affixed to discriminate from the pound weight. (See Weights and Measures.) (3) In law, an enclosed space for keeping cattle which have strayed on another man's ground, until they are replevined or redeemed. When cattle are put into pound it falls to the person impounding them to feed them, but he is entitled to charge the owner of the cattle the cost of keeping them in settling with him for the amount of damages to be paid. In England, an attempt to release from a pound cattle lawfully impounded is punishable by a fine. In Scotland the seizing of stray cattle and keeping them till damages are paid is called poinding of cattle.

Pound-net Fishing, any fishing which is conducted by means of fixed enclosures of considerable size into which the fish are led by suitable guides, and within which they are confined by appropriate devices. Under this head will be included the pound-nets proper and trap-nets, as well as the simpler forms of weirs, which together constitute a class of automatic fishing gear quite distinct from the various forms of seines, gill-nets, etc., on the one hand, and the small fish-traps, baskets and eel-pots on the other. Devices of this sort are employed in the prosecution of the fisheries in many parts of the world, but the method, although not originating in the United States, has here been more highly elaborated and is more characteristic of our fisheries than elsewhere. The precise form and construction of pound-nets varies greatly in different localities, owing to the necessity of adapting it to local conditions of bottom, tides, currents, the kind and number of the fish sought, the available capital, resourcefulness of the fishermen, etc.

Weirs.—The terms weir and pound in connection with the fisheries are to a great extent used interchangeably, according to local custom. The chief distinction between a weir and a pound-net seems to lie in the character of the enclosure within which the fish are confined. In the former this is more fixed and has no bottom which can be lifted; in the latter the pound is a netting bag which can be raised to the surface.

The most primitive apparatus of this sort in use in the United States is represented by the brush weirs employed in the herring fisheries of Maine and Canada. These consist of brush walls constructed in the following manner: Stout stakes from 6 to 8 inches in diameter at the butt, and 20 to 35 feet long, according to the depth of the water, are driven into the bottom to a distance of about 6 feet and 3 feet apart. Between these brush, preferably of cedar or spruce for the bottom course is woven in and out and held firmly in place by smaller stakes placed on the outside and bound to the large body-stakes. Toward the top a looser construction is adopted and the brush is placed vertically, as being less liable to be carried away by the current. Sometimes the brush is constructed in sections ashore and subsequently attached to stakes driven in the proper positions. This has the advantage that the brush sections can be removed and saved at the close of the fishing season, whereas the ordinary weirs, with the exception of such brush as can be removed from the tops, are likely to be totally destroyed by the winter's storms. When weirs are located on a bottom of solid rock into which no stakes can be driven, recourse is had to the construction of a platform of solid plank, which serves as a bottom to which the poles are fastened. The whole is heavily weighted and held in place by loading it with stones. In form and size scarcely two weirs are alike, but each is adapted to the topography of the bottom and the character of the currents to which it is related; and so varied are they that each is known to the local fishermen by a specific name. New weirs are constructed each spring, and the fishermen study with great care the arrangements of the channels, the conformation of the bottom, the set and force of the currents and especially the roadways along which the schools of herring move, locating their weirs with the idea of intercepting the greatest possible number of fish. The simplest form is perhaps the tidal weir, so arranged that fish can enter at openings through which the water flows during the last half of the flood tide, but find their retreat cut off during the last half of the ebb. The captured fishes are left stranded at low water and can be gathered by hand. This form of weir has, however, been practically abandoned, and more elaborate structures with wings and leaders adopted. These have the advantage of acting all through either the flood or the ebb tide or both. In a typical weir of this type the inner enclosure is more or less circular and perhaps 100 to 150 feet in diameter, with a mouth about 15 feet wide. The wings are of similar construction and about 100 to 150 feet long, diverging from the entrance of the weir into which they enter as the sides of a wedge-shaped passageway leading to an interior entrance about 10 feet wide. The outer ends of the wings are curved or hooked in various ways in order to direct toward the weir any fishes swimming in their direction. Leaders or centre fences are also walls of brush passing from the shore or bar to a point between the outer hooks of the wings. They may be several hundred feet long and are arranged at various angles to the weir proper. Among the fishermen a complete weir, with all the parts just described and of more or less symmetrical plan, is known as a patent weir; but very often the conformation of the shore or the presence of a bar or small island is taken advantage of and used as a substitute for the leader, for one or both of the wings, or for a part of the wall of the enclosure, in order to lessen the labor of construction. As a result we have bar weirs, shore weirs, channel weirs, etc. Sometimes a trap-door of netting is so placed across the mouth of the weir that it can be readily raised by pressure from without, but resists a push from within, thus furnishing an additional safeguard against the escape of captives. Owing to their construction the most effective method of fishing these weirs is by drawing a seine through them and thus removing the catch whenever desirable and expedient. Usually this is done at low water.

The use of true brush weirs is almost entirely limited to the waters of Passamaquoddy Bay. Where weirs are employed elsewhere in the United States their walls are usually constructed in whole or in part of cotton-twine netting. In the salmon fisheries of the Penobscot River and Bay a form of weir is employed in which the leader or run and the wings are constructed of spruce poles and alder brush, the second and third pounds of netting and provided with wooden floors so placed that the fish are left stranded at low water on the floor of the third or fish pound. The several pounds are arranged either across the channel or parallel to the shore. In the Kennebec River the shad weirs are, with the exception of the leader, which may be of brush, constructed entirely of netting, and they have no floor save the bottom of the river. They are fished by means of small seines. In a few places laths have been substituted for brush in the construction of small weirs. On the north shore of Cape Cod, where the bottom is sandy and very gently shelving, the leaders are often half a mile long and even then the bottom of the weirs is nearly dry at low water. These shallow-water weirs are fished in a unique manner. At low water light two-wheeled carts are driven to them across the sands and the fish are simply shoveled or bailed into them and carried to the shore.

Pounds.— A pound-net in the more restricted sense of the term is constructed entirely of cordage netting, supported and held in place by stakes, and consists of three essential parts: the pound or bowl, the wings and the leader. The pound is located off-shore, usually in from two to four fathoms of water and consists of a bag of very stout netting of about one inch mesh, the margin of which is supported above the level of the water by stout upright stakes driven into the bottom at suitable intervals which vary with the character of the ground and the force of the waves and currents. Where the bottom is rocky further security is found by the attachment of anchored guy ropes to some of the stakes. The only opening in the pound is the slit-like entrance, usually about six feet across, on the inshore side. At this point the walls of the net are carried inward, in order to render the opening less conspicuous from the inside, and are so arranged that by means of suitable ropes they may be used to close the opening when the net is drawn. The bottom of the pound is spread and secured by means of ropes which pass through loops or pulleys near the bottom of the stakes. The pound varies in diameter from 45 to 90 feet or more, and in shape may be circular, heart-shaped, rectangular or irregular, according to local custom and circumstances. Sometimes the pound is divided into inner and outer compartments, in which case the former is the real pound in which the fish are collected and retained; or the division may be so arranged as to classify the contents, as in the case of the pound-nets of Delaware Bay, many of which segregate the king crabs in staked enclosures. To many pound-nets is also appended at the side a pocket or netting bag of convenient size and shape for the purpose of keeping fish alive after they have been removed from the pound, when it is desirable not to market them immediately.

The wings are vertical fences of netting, diverging from the entrance to the pound and having a length of 100 feet or more. The ends directed toward the shore are carried toward one another in the form of a semicircle, but leaving a wide opening between the two wings. The netting of which the wings are constructed is lighter than that forming the pound, and of about 1½ inches mesh. It is supported by stakes and reaches from the bottom to the surface, the lower border being weighted with a heavy chain. The exact arrangement of the wings varies endlessly; sometimes there is but one; sometimes they have the form of an arrow-head; frequently there are two sets, one forming the inner or smaller "heart" which opens directly into the pound, and receives the open apical end of the outer or large "heart." But whatever their form they are designed to direct the fish toward the mouth of the pound, and to present as many obstacles as possible to its passage in the opposite direction. The leader is simply a straight fence of netting running from a point at or near the shore to just within the opening between the wings. It is made of lighter cordage and much larger mesh than either the pound or wings and lengths of heavy chain or other sinkers attached to the lower margin serve to keep it close to the bottom, the upper edge being supported at the level of high water by stakes.

The cordage pound-net is capable of almost unlimited modification, and the fishermen have shown the greatest ingenuity in adapting the principle to local and special requirements. Perhaps the most perfect and efficient form has been developed on the Great Lakes, where the pounds are often set in water of considerable depth, and the bag or pound proper may be as much as fifty feet or even more deep, with the entrance in the form of a funnel projecting into its interior. Size and shape of pound and wings vary with the conformation of the ground, kind and abundance of fish and direction of currents, but are very largely governed by local prejudices and regulations, or by the amount of capital available. The size of mesh and twine in pound, wings and leader also varies greatly, being controlled by the strength of the currents, the amount of eel grass, marine algæ and flotsam which accumulates, the kinds of fishes sought, and sometimes by local regulations and customs which have little apparent relation to the natural factors. A leader constructed of netting having a large open mesh collects less floating material and is consequently less likely to be carried away by strong currents than one of small and close mesh, and is almost as effective in directing fishes into the wings as the latter. In the wings and pound, however, and especially in the latter, the mesh must be sufficiently close to retain the valuable kinds of fishes in the blind and the vigorous dashes for freedom which follow the discovery of their imprisonment. Generally in the sea-fisheries everything, from herring, or even bait-fish and squids, to bonitos and sturgeon, is desired; and the nets must be stout enough to withstand the fierce rushes of sharks or other sea-monsters. Consequently a small mesh of very stout twine, often reinforced by slings of stout rope, is employed. If the fisheries are specialized and only a particular kind of fish, as whitefish, shad or salmon, is desired, the net can be endowed with a certain selective property by using a mesh just small enough to retain that kind, while permitting the escape of all of smaller size. As the object of leaders is to intercept the moving schools of fishes and to direct them toward the enclosure, they are naturally placed in such positions as the fishermen's knowledge of local movements and conditions dictates. They may begin at or near a shore or at the edge of a bar and their length varies greatly with the gentleness or abruptness of the slope of the bottom, and is further controlled by navigation laws prohibiting the obstruction of channels. Sometimes owing to local topography or to the set of the current continuously in one direction the leader is arranged with an opening on one side only so that fishes swimming in but one direction are taken. When located in tidal waters, however, they usually have double wings and openings so that they operate with both ebb and flow of the tide and are effective against fishes moving both up and down the shore. Frequently when the bottom slopes very gently, and the fish are known to move diffusely or in scattered schools, several pound-nets are arranged in lines or series, the leader of one beginning at the outer end of the pound of another. On the Atlantic coast pound-nets are generally placed singly and very rarely are more than two placed on a line, but in Lake Erie four or even more may be arranged in a series, the last member of which may reach far out into the lake and into deep water. Such lines must be extremely effective and almost completely obstruct the passage of larger fish. But perhaps the greatest ingenuity is shown in the methods of fastening the nets to the bottom. Usually stout stakes of oak or other wood are employed, varying in number, length and thickness according to requirements. Where the bottom is of mud, clay or sand, these are driven in by use of a pile-driver, maul, or other means, for about six feet, more or less, according to the holding quality of the ground, force of current, etc. When the bottom is soft and the stakes small a man is often suspended in a sling from the top and the stake worked into the ground by swinging it back and forth. On sandy bottoms suction-pump and force-pump pile-drivers are sometimes employed for driving the stakes. Where the bottom is very stony and the stakes difficult to drive and insecure in their hold, they are often supplemented by guy ropes attached to anchors, large stones, or large outlying piles. Anchored nets may be buoyed up by floats attached along the upper edge, and sometimes become practically floating pound-nets. Such nets, which are in use on the coast of Maine, are operated by a complex system of ropes. At places on the coast of Maine where the bottom is of solid rock it becomes necessary to attach the stakes to solid plank platforms weighted with heavy stones.

Trap-nets.— Any form of enclosure employed in the capture of fish may be called a trap, and trap-net is frequently used as an equivalent of pound-net. The best usage of the term, however, is to indicate those forms of pound-nets which are especially adapted to deep waters or a considerable tidal rise and fall by the attachment to the upper margin of the nets of floats which keep it always level with the surface. When surface-swimming fish only are sought, the parts which correspond to the leaders and wings of pound-nets frequently hang suspended above the bottom. The whole is of course held in position by a suitable system of ropes, anchors and moorings. This type of apparatus is an approach to the floating gill-net, the sets of which are often arranged in the form of leaders and enclosures.

Methods of Operation.— The method of fishing and caring for pound-nets of course differs in details according to the locality and size of the net, tides, currents, disposition of catch and numerous other factors, but is essentially the same everywhere. Usually three or four men constitute a fishing-crew, who proceed to the net in a large scow-like boat. The first operation is to loosen the bottom-lines which keep the pound distended. This is done successively at each stake around the entire circumference of the pound. At a point especially designed as an entrance and usually situated at one side of the mouth of the pound, the edge of the net is then lowered just sufficiently to admit the boat, and immediately after its entrance is again raised. The mouth of the pound is then closed, and the men begin to lift the net and pile it in the boat, proceeding slowly forward, so that the fish are crowded into a continuously diminishing space. The area into which they are finally "bunted" is frequently constructed of stouter twine in order to withstand the strain imposed upon it by a large catch. The fish are then bailed out with dip-nets, either into the fishing boat or into another boat which has been stationed on the outside of the net or into the pocket at the side of the pound. Except under special circumstances, as when the fares are very small, or during the progress of severe storms, it is customary to fish pound-nets on every week-day, preferably at low water, or occasionally, when the run of valuable fish is unusually heavy, even twice a day.

Places and Seasons.— Notwithstanding the great ingenuity exercised, pound-net fishing has certain limitations. These devices can be effective only in the comparatively shallow waters in the proximity of shores or bars, and on relatively smooth bottoms, though the former difficulty has been somewhat overcome for certain classes of fishes by the invention of the floating trap and the latter by the construction of artificial floors. A more serious obstacle is their inability to withstand the beating of severe storms or heavy surf. The ideal location is in a sheltered bay or estuary, where the bottom slopes gently to a channel washed by strong tidal currents and serving as a roadway for migrating schools of valuable fishes. The absence of pound-nets from great stretches of our coast and their concentration at certain favored points is due more to these factors than to the distribution of valuable kinds of fishes. A very brief review of the geographical distribution of pounds and weirs may be given. Brush weirs are nearly peculiar to the fisheries of Maine and in the typical form are nearly restricted to the capture of herring on both the Canadian and American sides of Passamaquoddy Bay. Netting weirs are largely employed in the bays and rivers of Maine, on the north shore of Cape Cod, in Narragansett Bay, parts of Delaware and Chesapeake Bays, Albemarle Sound and the Great Lakes. Of true pound-nets a few are found on the coast of Maine, a great many in Vineyard Sound and other waters south of Cape Cod, where perhaps the most important pound fisheries of the country exist, some large ones in Long Island Sound and the neighborhood of New York harbor, others in the bays and even on the ocean front of New Jersey, in Delaware Bay and a very large number in Chesapeake Bay and the lower parts of its tributary rivers. The southernmost point on the Atlantic coast at which pound-nets are employed to any considerable extent is in Albemarle Sound. In the fisheries of the Great Lakes and especially at the western end of Lake Erie pound-nets are very extensively employed. On the Pacific coast they have been adopted only in the lower waters of the Columbia River, where they have now almost completely superseded the old form of wooden trap in the salmon fisheries. It will be observed that from the entire Gulf coast and the greater part of the southern Atlantic and Pacific coasts of the United States pound-nets are practically absent. Several years ago an attempt was made to use pound-nets on the coast of Texas, but the frequent tearing of the nets by sharks, large gars, etc., permitting the escape of the contents, led to their abandonment. It is quite probable, however, that this difficulty could be overcome by the construction of weirs of galvanized-iron wire-netting and that their employment in southern waters in the vicinity of large cities would prove extremely profitable. The prevalence of severe storms during the winter has rendered the operation of pound-nets feasible only in the warmer months and this also has prevented their use widely in the South, in many parts of which facilities for preservation and rapid transportation of fish are lacking. In most places the extreme limits of the fishing season are the months of April and November, and even within this period the nets are sometimes completely wrecked by storms; and on many days the more exposed nets are quite inaccessible even to the hardy and experienced fishermen who operate them.

Importance, Extent and Products.— If a classification of the fisheries of the United States according to the kind of apparatus employed were made, it is altogether probable that those conducted by means of pound-nets and weirs would rank first in the value of their product. While the complete data for an estimate of this sort are not available the great importance of this class of apparatus may be appreciated by a review of a few statistical facts relating to some of the fisheries in which it is employed. For the shad fishery, one of the most important of the Atlantic coast rivers and bays, the latest complete statistics published cover the year 1896. During that season 13,714,755 shad, having a value to the fishermen of $1,655,000, were taken by all kinds of apparatus. Of this number 3,139,830, valued at $361,632, were captured in the 3,810 pound-nets set especially for this purpose, and about 750,000 more from others from which returns were received. These nets were valued at $464,062 and 3,076 persons were employed in their operation. By far the most important centre for this fishery is located in Chesapeake Bay and its tributaries, which yielded from pound-nets alone about one fourth, and from all kinds of apparatus about one half of the entire product of the United States. The next most important pound-net shad fishery is in Pamlico and Albemarle Sounds. Very few shad are taken in the ocean-front pounds of New Jersey and elsewhere, but considerable numbers in the river weirs of Maine. The herring used in the sardine factories of Maine are practically all yielded by the brush weir fisheries of Passamaquoddy Bay, covering an area of about 100 square miles. In 1895, 384 weirs were located in these waters and supplied the canneries in the vicinity of Eastport with 47,979 hogsheads of herring of 1,000 pounds each, with a value to the fishermen of $99,845. Of these weirs 331 were on the Canadian and 53 on the American side, the latter valued at $28,483, operated by 139 fishermen, and yielding 9,683 hogsheads of herring having a value of $15,134. In 1892, 378 pound-nets, valued at $276,800, were employed in the salmon fisheries of the lower Columbia River in Oregon and Washington. They captured that year 8,788,685 pounds of salmon, valued at $275,059. The alewife fisheries of the Atlantic coast yielded in 1896 more than 60,000,000 alewives, valued at $460,000, as the product of pound-nets and weirs.

A few figures showing the value of the apparatus at some of the chief centres of the pound-net fisheries will be further instructive. In each case the figures are given for the nets and weirs alone and are exclusive of valuations of boats and all kinds of shore property and accessory apparatus. In 1898 the number of weirs and pounds-nets in use in the New England States was 1,096, with an aggregate value of $405,424. The Middle States, Maryland and Virginia employed in 1897 no less than 2,491 pound-nets, trap-nets and weirs valued at $499,115. The number of the same class of apparatus in use in Lake Erie in 1899 was 1,724, valued at $245,561. In the lower Columbia River region, the only locality where pound-nets are in use on the Pacific coast, the figures for 1895 are 423 pounds and traps, worth $309,675. Leaving out of consideration vessels and boats, which are employed in connection with all kinds of apparatus, the value of pound-nets and weirs exceeded that of any other single class of fishing property in the first three regions, and in the fourth fell below that of seines only. In the Saginaw Bay region of Lake Huron as much as three fourths of the product of the fisheries comes from the pound-nets and trap-nets. In Massachusetts in 1880, when the pound-nets were valued at $76,875, they produced fish having an original value of $210,000. The variety of fishes taken in pound-nets is no less remarkable than the quantity. Among the most important are salmon, shad, bluefish, herring, alewives, Spanish mackerel, mackerel, bonito, scup, weakfish or squeteague, sea bass, tautog, smelt, cod, flounder, striped bass, butterfish, kingfish, pompano, sturgeon, whitefish, perch, pike-perch, and sheepshead, besides many smaller food-fishes and the various kinds used for bait and ground up for fertilizer.

Financial Organization and Profits.— While the smaller and simpler forms of weirs may be built at very slight expense the construction and operation of the larger and more elaborate kinds of pound-nets requires considerable capital. Consequently the organization of the owners and their financial arrangements differ almost as widely as the modifications of the apparatus. Naturally the fishermen themselves are primarily concerned and the simplest arrangement is that in which several combine, as in the brush-weir fisheries of Maine, and together supply all necessary labor and capital and share the product. Sometimes small stock companies are so formed. As a result of these various agreements, many curious local customs and practices have grown up, often having all the force of written laws and, indeed, some of them have come to be embodied in the actual law. Very often a number of pound-nets located at widely different points are owned by a wealthy man or group of men, who employ on regular wages local foremen and fishing crews, arrange for the disposal of the product and derive handsome incomes from their investment. Of late years the tendency toward completer organization and the economy of operation on a large scale has led to the formation of large stock companies with abundant capital. Wherever the field is sufficiently tempting, as in the Great Lakes, Chesapeake Bay, on the New Jersey coast, and elsewhere, such corporations are now engaged in pound-net fishing. They own many pounds, with fleets of boats, including steam tugs, and employ many men. Such companies are generally financially prosperous, pay large dividends, and have become powerful influences in our fisheries. The profits of pound and weir fishing are often very great, but, like all kinds of fishing, are subject to periodical wax and wane, the result of unforeseen and uncontrollable factors. It is known that some of the largest and best located pound-nets will often yield from $5,000 to $7,000 net profit in a single good season, and some of the companies have paid annual dividends of 20 per cent.

Legislation.— Various laws have been passed to regulate weir and pound-fishing. Many of these have reference to the obstruction of navigable waters, prohibiting the extension of nets into channels beyond a certain distance, or, where long lines of pound-nets are employed on shelving bottoms, requiring that suitably marked gateways for the passage of small boats be left at proper places. Others determine the length of the fishing season, relations, and responsibilities of the owners, etc. Frequently the fishing rights along a shore are controlled by the local township government, and privileges are rented upon the payment of a license fee. In such cases the rights cover a certain specified extent of shore, and the length of the leaders, distance between pounds, and other conditions affecting neighboring fishermen are regulated. Shore privileges are of course secured from the owner of the land. Owing to an apparent correlation between the introduction of pound-nets and a local diminution in the numbers of certain shore fishes, pound-nets have found bitter opponents in the ranks of the more conservative hand-line fishermen, anglers, and others who view the pound-net as a destructive agency, the employment of which transgresses their rights. Consequently many bills have been introduced into State legislatures and even into the Federal Congress either totally prohibiting or greatly restricting the use of pound-nets in waters over which these bodies have jurisdiction. While some of the less drastic of these measures have occasionally become laws, prohibiting the use of pound-nets in certain bays, channels, and other waters of limited area, they have for the most part been defeated, partly through the activity of the powerful interests opposed to them, but chiefly because of the widespread opinion that the employment of the most effective methods in the fisheries is in the interests of the people at large. It is impossible in a brief article to discuss adequately this question and the charge of wasteful destructiveness which has been made against the pound-net fisheries. While it is apparent that many improvements in the utilization of the products of these and, indeed, of nearly all branches of our fisheries, are possible it has never been proved that the use of pound-nets is really detrimental to the other fisheries, nor that they are really responsible for the lessened abundance of certain sea fishes. While a diminution in the numbers of some species has been largely coincident with the introduction and growth of pound-net fishing in certain regions it is equally evident that other species, such as the herring and scup, have become more plentiful during the same period. The whole subject of fluctuations in abundance of sea-fishes is an exceedingly complex and little understood one; but, although some hold a contrary opinion, the general belief of close students of the sea-fisheries and of marine zoologists is that man is a factor of very slight importance in relation to the magnificent scheme of oceanic life.

History and Development of Pound-Fishing.— The essential principal of the weir and pound-net,— that of automatic utilization of the long-observed habit of most fishes of swimming for a time straight away in any direction toward which they have been turned by a sufficient obstruction,— is capable of almost indefinite development and has been employed by many peoples for long periods. All that is necessary is to utilize the materials at hand and, taking into consideration the habits of particular fishes and the local conditions, to construct an enclosure of such a form that the fish on the outside are insensibly led to the entrance and once within are induced by a labyrinth of walls to circle about in a vain attempt to discover an exit, which few succeed in finding. In many tropical coral islands large numbers of fishes are imprisoned by the receding tide in natural pools. It is only a step from the utilization of these by the natives to their improvement by opening or closing passages and finally to the artificial construction of stone enclosures of more or less complex form and often with leading walls and wings closely following the essential plan of our own pound-nets. All stages in the development of these stone weirs may be found in use by the natives of the various South Sea islands. Bamboo is excellently adapted to the construction of weirs and is much employed for this purpose in Oriental waters, some bamboo weirs of exceedingly ingenious design being used on the island of Guam. In Europe the use of weirs and fixed nets is practically unknown and indeed is in most countries prohibited. «Stake-nets» are still used to some extent in the British salmon fisheries. In North America weirs more or less rudely constructed of interwoven brush were employed by the Indians, chiefly in the capture of herring, before the advent of the white man. They were early adopted by the Canadian fishermen and were introduced into our waters from Nova Scotia in 1820. These early ones were of small size and of the half-tide type, but were gradually improved in plan and construction and increased in size as the demand for smoked herring increased. After the Civil War this demand declined and with it the Maine weir fisheries, but the latter have regained their importance with the growth of the sardine industry since 1875. Pound-nets were first used in our waters in Connecticut in 1850 and about the same time netting began to be employed in the weirs of Penobscot Bay and the double form was first substituted for the less efficient single hook type. On the New Jersey coast the first pound-net was set on the inner shore of Sandy Hook in 1855, and 20 years later, after the discovery of their importance in the Spanish mackerel fishery, their use became general in these waters, wherein some of the largest and most lucrative pound-nets in the country are now located. Against the construction of a pound-net on the Virginia shore of Chesapeake Bay in 1858 the prejudices of the local fishermen were so strong that it was removed at night and carried ashore and the owner was forced to remove to a more friendly neighborhood. However, the seed was sown and in a few years the rapid introduction of pound-nets into that region so completely revolutionized the fisheries that they have grown from almost nothing to be among the most important in the country. Once established at these important points pound-nets have grown rapidly in favor. As their use extended, new forms and modifications have appeared and they have been adapted to an ever widening variety of conditions and kinds of fishes.

Bibliography.— Much information relating to all phases of the use of pound-nets in the American fisheries will be found scattered through the 'Annual Reports' of the United States Bureau of Fisheries and of the commissions of the various States in which these fisheries are located, and especially in the 'Fisheries Industries of the United States' (Washington 1884–7).

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Poundal. See Force and Mechanics.

Pourbus, poor-büs, **Frans,** The Elder, Flemish painter: b. Bruges 1545; d. Antwerp 19 Sept. 1581. He was a pupil of his father Pieter, the younger, and of Frans Florus, and became a free master of the Guild of St. Luke at Antwerp in 1564. He died of a malignant fever caught in the guard house of the civic guard of which he was standard bearer. His wife, the daughter of Frans Florus, married Jordaens, the painter, after the death of Pourbus. He painted historical subjects, landscapes, animals and portraits: in the last named department his work is best known. Several religious subjects are to be found in the cathedrals of Ghent and Tournai.

Pourbus, Frans, The Younger, Flemish painter: b. Antwerp 1570; d. Paris Feb. 1622. He was a pupil of his father and doubtless studied with others, for his father died when he was ten. He was a free master of the Guild of St

Luke in 1591. After 1600 he resided at Brussels, then in Italy at the court of the Duke of Mantua, and after 1610 was court painter to Henry IV. of France. Of the latter monarch he painted several portraits, also he painted Maria de' Medicis, the Louvre portrait of the queen being accounted his greatest work. A portrait of Catherine de' Medicis from his hands is in Madrid. His portraits are inferior to those of his father in warmth of color.

Pourbus, Pieter, THE ELDER, Flemish painter: b. probably Gouda 1463. He is supposed to be the father of Pieter the younger and grandfather of Frans the elder. A portrait of a goldsmith, now at Vienna, is assigned to him.

Pourbus, Pieter, THE YOUNGER, Flemish painter: b. probably Bruges 1510 or 1513; d. there 1584. He was a pupil of his father and probably of Lancelot Blondeel whose daughter he married. In 1540 he entered the Serment des Arbaletriers de S. George and in 1543 became a free master of the Guild of St. Luke, of which he was «doyen» in 1569 and 1580. As he did not buy his citizenship at Bruges it is argued that his father must have moved thither from Gouda before his birth. He worked as decorator and surveyor, having remarkable gifts as a geometrician; but he is known chiefly as a portrait painter. His portrait of Dr. Ambrose Paré is owned by the Historical Society of New York.

Pourtalès, poor'ta-lā, **Louis François de,** Swiss-American naturalist: b. Neuchâtel, Switzerland, 4 March 1824; d. Beverly Farms, Mass., 19 July 1880. He studied engineering but turned to natural science; was a pupil of Louis Agassiz (q.v.), whom he assisted in 1840 in an exploration of Alpine glaciers; and in 1847 came with him to America, where the next year he entered the United States coast-survey. He was the first in this country to attempt deep-sea dredging. Among his important researches in this field being those conducted during the Hassler expedition from Massachusetts Bay to California by way of the Straits of Magellan. From 1854 until his resignation from the survey in 1873, he was in charge of the office and field work of the tidal division. His chief work was accomplished in marine zoology, and the large collections accumulated by him in connection with that subject were deposited in the Cambridge museum of comparative zoology in which he became an assistant in 1873, and as keeper of which he succeeded Agassiz. The genus *Pourtalesia* of sea-urchins was named after him. His writings include besides articles in scientific journals and contributions to the survey reports, the following works among several published by the Cambridge museum: 'List of the Crinoids Obtained on the Coasts of Florida and Cuba in 1867–9' (1869); 'Deep-Sea Corals' (1871); 'The Zoölogical Results of the Hassler Expedition' (with A. Agassiz, 1874); 'Corals and Crinoids' (1878); a report on 'Corals and Antipatheria' (1880).

Poushkin. See PUSHKIN.

Poussin, poo-săṅ, **Gaspar,** Italian painter: b. Rome 1613; d. there 15 May 1675. He was the son of a Frenchman named Dughet, who had settled at Rome but in signing his etchings he Italianized the paternal name into Duche. When his sister married Nicolas Poussin he took the name of his brother-in-law, whose studio he entered as pupil. The standard landscape of his day was that of Claude Lorraine, but Poussin was not so conventionally classical but more true to the animalism of nature than his great rival, the transparent lucidity of whose aerial perspective he never attained to. As he painted on a red background his pictures have so darkened by age that it is hard to imagine their effect when first produced. It can, however, be seen that he discerned the true lines of a landscape, that he composed with natural grace his groups of forest trees and antique ruins; and that his land storms, in which the trees seem to quiver and bend, are genuine transcripts from tempest-harried plain and mountain. He was imitated by many painters of his day. Most of his pictures are at Rome. They are painted in tempera or oil, and examples of both styles may be seen in the Palazzi Doria, Colonna and Corsini and in the gallery of the Accademia di San Luca. At Rome he executed the frescoes 'History of Elijah and Elisha' in the church of San Martino a' Monti. There are pictures of his to be found in the galleries of Paris, Saint Petersburg, Madrid, and Dresden, and a great number are scattered through the private galleries of England. The most famous of his works in the latter country is 'The Calling of Abraham' which was bought by the nation in 1882 for $9,975. It was originally in the Colonna collection; afterward belonged to Beckford at Fonthill; and passed through the hands of a third owner to its present ownership.

Poussin, Nicolas, French painter: b. Les Andelys, Normandy, 15 June 1593; d. Rome 19 Nov. 1665. He studied first in his native place, and then at Paris. He had already acquired considerable reputation when, in 1624, he went to Italy, where at Rome, Marini, the poet, inspired him with a taste for the Italian poets, in whose works Poussin found many subjects for his art. After the death of Marini (1625), though left without patronage, he continued the study of geometry, perspective, architecture, anatomy, as well as the practice of his art. His conversation, his walks, his readings were also almost always connected with it. He copied antiques, modeled statues and reliefs, diligently painted from nature; and all his works show the results of this study. At last he was attacked by an illness brought on by his labors. He was, however, taken care of by a Frenchman, Jacques Dughet, the father of Gaspar Poussin (q.v.). In 1630 Poussin married the daughter of his benefactor. About this time his affairs began to improve. He found patrons in Cardinal Barberini and the Cavaliere Cassiano del Pozzo, for whom he painted the celebrated 'Seven Sacraments.' These works likewise gained him celebrity in France; and Cardinal Richelieu invited him to Paris to paint the great gallery of the Louvre. Louis XIII. appointed him his first painter, with a pension of 3,000 livres. Poussin arrived in Paris in 1640, and executed numerous works, particularly historical pieces from the Old Testament, and a repetition of his 'Seven Sacraments,' but was much harassed by his enemies. The painter Jacques Fouquières had been employed to decorate the gallery and the architect Mercier had overloaded it with ornament. Poussin found himself under the necessity of removing their labors. He also had to contend with the whole school of Simon Vouet. Harassed on every side he determined to leave Paris. In September 1642 while employed on cartoons of the 'Labors of Hercules' for the gallery of the Louvre, he returned to Rome (ostensibly for the purpose of bringing his wife to France) and never again quitted that city. As a painter his drawing is remarkably correct; his composition dignified, and noble, his invention rich: his style grand and heroic. His expression approaches that of Raphael, and he has been called the Raphael of France. He has been censured for a too studied arrangement, and a too great propensity to episodes; too much uniformity in the attitudes, air, and expression of his figures; an excessive fulness in the drapery, and too small proportions in his figures — faults which may have been owing to his close imitation of the ancients. But notwithstanding these faults Poussin may be compared with the greatest Italian masters. Among his most celebrated works are: 'Seven Sacraments'; 'Deluge'; 'Death of Germanicus'; 'Capture of Jerusalem'; 'Plague of the Philistines'; 'Rebecca'; 'The Adulteress'; 'The Infant Moses'; 'Moses bringing Water from the Rock'; 'The Worship of the Golden Calf'; 'John Baptizing in the Wilderness'; etc., and many fine landscapes. Consult: Bouchitté, 'Le Poussin' (1858); Poillon, 'Nicolas Poussin, Etude Biographique' (1875).

Pout, or **Horned Pout.** See Bullheads.

Pou'ter, a variety of fancy pigeon, the chief character of which is its projecting highly inflatable breast. See Pigeon.

Poutrincourt, poo-trăṅ-koor, **Jean de Biencourt,** Sieur de, French soldier: b. France 1557; d. Mery-sur-Seine 1615. In 1603 he came to Canada, where De Monts made him a lieutenant, and in 1604 received a grant of Port Royal and established there a colony of which he took little care. The grant was confirmed in 1607, and at the same time the king urged Poutrincourt to labor for the conversion of the savages. Desirous of keeping the Jesuits from Port Royal, he delayed their departure from France, sent back glowing accounts of his own missionary success, and welcomed the Jesuits very ungraciously. He went to France in 1612, and after the English left Acadia sailed thither in 1614, but did nothing to rebuild Port Royal.

Pow-wow, an American Indian term meaning (1) a ceremony, with conjurations, held for the curing of diseases; (2) a consultation of chiefs or leaders; a deliberation over important tribal matters. In colloquial use pow-wow is used in American politics as applied to any noisy meeting or gathering.

Pow'der, a general name applied to explosives as gun powder, giant powder, etc. See Explosives.

Powder-down Feathers. See Plumage.

Pow'derly, Terence Vincent, American labor leader and lawyer: b. Carbondale, Pa., 22 Jan. 1849. His early education was obtained in the public schools and he then (1862) became a railroad switch tender. At 17 he became a machinist's apprentice, settled in Scranton, Pa., in 1866, and there worked as a machinist until 1877. He was elected mayor of that city on the Labor ticket in 1878 and re-elected in 1880 and 1882. He was General Master-Workman of the Knights of Labor in 1879–93, but resigning in the last named year took up the study of law, and was admitted to the bar of Lackawanna County, and in 1901 to that of the Supreme Court of the United States. He was United States commissioner-general of immigration 1897–1902. He has lectured frequently, made many Republican campaign speeches in 1896 and 1900, and published 'Thirty Years of Labor 1858–89' (1899–1900); 'History of Labor Day'; etc.

Pow'ell, Baden, English Anglican clergyman and mathematician: b. Stamford Hill, London, 22 Aug. 1796; d. London 11 June 1860. He was graduated from Oxford in 1814, took orders in the English Church and became vicar of Plumstead, Kent, in 1821. He was elected a fellow of the Royal Society in 1824, and in 1827 was appointed Savilian professor of geometry at Oxford, on which occasion he resigned his living of Plumstead. He contributed many papers on optics, radiant heat, and other physical subjects to the 'Philosophical Transactions,' but it better known by his essay in the celebrated 'Essays and Reviews' (1860), on 'The Study of the Evidences of Christianity.' Earlier theological works of a similarly liberal character are: 'The Connexion of Natural and Divine Truth' (1838); 'Tradition Unveiled' (1839); 'The Unity of Worlds' (1855); 'The Study of Natural Theology' (1856); 'Christianity without Judaism' (1857); and 'The Order of Nature' (1859). See Baden Powell.

Powell, Edward Payson, American Unitarian clergyman and author: b. Clinton, N. Y., 1833. He was graduated from Hamilton College in his native town and from Union Theological Seminary, New York, in 1858. Entering the Congregational ministry he was pastor at Adrian, Mich., 1860–71, and of the Second Congregational Church, St. Louis, 1871–4. From 1874 to 1877 he held a Unitarian pastorate in Chicago and has since been editorially connected with secular and religious journals. He has published: 'Our Heredity from God' (1886); 'Liberty and Life' (1890); 'Nullification and Secession in the United States' (1896); 'Wind-breaks, Hedges, and Shelters' (1900); 'The Orchard and Fruit Garden' (1904).

Powell, Frederick York, English historical writer: b. 1850. He was educated at Rugby and Oxford and has been regius professor of modern history at Oxford from 1894. He is widely known as an Icelandic scholar, and with Vigfusson edited the 'Corpus Poeticum Boreale' (1883); 'Icelandic Reader'; and 'Icelandic Antiqua.' He is the author of 'Early England up to the Norman Conquest'; 'Alfred the Great and William the Conqueror'; 'Old Stories from English History' (1894); 'History of England to 1509.'

Powell, John Wesley, American geologist: b. Mount Morris, N. Y., 24 March 1834; d. Haven, Maine, 23 Sept. 1902. He was educated at Illinois and Wheaton colleges, studied also at Oberlin, made researches in natural history and geology, at the outbreak of the Civil War enlisted as a private in the 20th Illinois volunteers, became before the close of the war lieutenant-colonel of the 2d Illinois. In 1865 he was appointed professor of geology and curator of the museum at Illinois Wesleyan University.

but later became professor of geology in Illinois Normal University. He conducted in 1868 a perilous exploration of the grand cañon of the Colorado, and in 1870 took charge of the newly established geological and topographical survey of the Colorado River of the West. By this survey nearly 100,000 miles of the Colorado Valley were carefully explored. The work was subsequently transferred to the Interior Department; by 1874 there were four surveys in the field; and this led in 1879 to the establishment of the organization known as the United States Geological Survey, in the formation of which Powell was largely instrumental. From 1881 to 1894 he was director of the survey. He also made particular study of American ethnology, and obtained the organization of the Bureau of Ethnology, which he trained on a high plane of scientific efficiency. His studies of the Indians are deemed of great value. As administrator of the survey, which included also economic geology, geography, and palæontology, he was very successful. Latterly he devoted considerable attention to philosophy and psychology. He secured valuable legislation in connection with the land laws affecting the development of the arid West. Among his writings are: 'Exploration of the Colorado River' (1875); 'Report on the Geology of the Uinta Mountains' (1876); 'Introduction to the Study of Indian Languages' (1880); 'Studies in Sociology' (1887); and 'Truth and Error' (1899).

Powell, William Byrd, American physician and cerebral physiologist: b. Bourbon County, Ky., 8 Jan. 1799; d. Cincinnati, Ohio, 13 May 1866. He became noted by reason of his work, 'The Natural History of the Human Temperaments' (1856), announcing the theory known as Powell's life-line, and his novel views concerning the results of marriage within near or prohibited degrees of consanguinity. He was graduated from Transylvania University, at Lexington, Ky., in 1820 and from the Transylvania Medical School in 1823. In 1835 he was appointed professor of chemistry in the Medical College of Louisiana, holding that position for several years. In 1843 he began a sojourn among the American Indians, adopting their dress and manners in order to study their habits, dispositions, longevity, etc., and secured the crania of many warriors and chiefs. In 1847 he organized at Memphis, Tenn., the Memphis Institute, and held the chair of cerebral physiology in the Eclectic Medical Institute of Cincinnati 1856-8. He bequeathed his head to his literary executor to be preserved with his collection of crania.

Pow'elson, Wilfred Van Nest, American naval officer: b. Middletown, N. Y., 15 Sept. 1872. He was graduated from the American Naval Academy in 1893 and was then sent by the government to study naval architecture at the University of Glasgow. While serving on the Fern at Key West he was ordered to pursue examinations regarding the destruction of the Maine in the harbor of Havana and his published report stating that the Maine was sunk by an exploded mine was much discussed by scientific periodicals. He was promoted lieutenant in March 1901.

Pow'er (William Grattan), Tyrone, Irish actor: b. near Kilmacthomas, county Waterford, 1795; lost at sea 1841. He made his début as Romeo in 1813 at Cardiff, Wales. In 1821 he appeared in London, where he made a hit as Larry Hooligan O'Halloran in 1824, and henceforth devoted himself to impersonations of Irish characters in which he was inimitable. He visited the United States in 1833 and in 1840, and in 1841 embarked for Europe on the President, which was never again heard of. He published: 'The King's Secret'; 'The Lost Heir'; 'Impressions of America' (1835); etc.

Power, in arithmetic, and in the algebra of real numbers, the product obtained by multiplying a given number by itself a specified number of times. If x is the given number, and n is the number of times that x is taken as a factor in forming the product, then the product that is finally obtained is

$$x \times x \times x \times \quad . \; . \; . \; . \quad \times x \times x \times x$$

(n factors altogether)

This is called the "nth power" of the number x, and is represented by the symbol x^n. Assuming for the moment that n (which is called the "exponent" of the power) is positive and integral (since this is the only case in which the foregoing definition is applicable), we easily obtain the following general laws which the powers of numbers must fulfil: $x^m . x^n = x^{m+n}$; $(x^m)^n = x^{mn}$; $(xy)^n = x^n y^n$. To extend the conception of a "power" so as to permit of the use of fractional and negative exponents, we may assume that the foregoing laws hold true of all real exponents, and from them we may seek the interpretations that must be given to an expression of the form x^n, when n is fractional or negative. First, if we make $m = o$ in the equation $x^m . x^n = x^{m+n}$ we have $x^o . x^n = x^n$; and hence we conclude that the symbol x^o must be interpreted as representing unity in all cases. Again, if we make $n = - m$, we have, from the first of the general relations given above, $x^m . x^{-m} = x^{m-m} = x^o = 1$ and hence we must interpret the expression x^{-m} as signifying the reciprocal of x^m. We may ascertain the significance of a fractional exponent by means of the second general relation, bove. Thus in the identity $(x^m)^n = x^{mn}$, let us put $m = \frac{1}{n}$. Then we have $(x^{\frac{1}{n}})^n = x^{\frac{n}{n}} = x^1 = x$. Hence $x^{\frac{1}{n}}$ must be interpreted as representing that quantity which, when raised to the nth power, will yield x itself. That is, we must interpret $x^{\frac{1}{n}}$ as equivalent to $\sqrt[n]{x}$. In a similar manner it is easily shown that the symbol $x^{\frac{m}{n}}$ must be interpreted as equivalent to $\sqrt[n]{x^m}$.

The significance of a power, when the exponent and the number itself are both imaginary, is considered in the theory of functions, but this generalization is too difficult for sound treatment in the present article. For this aspect of the subject, and for the discussion of the development of functions of a variable in a series whose terms are powers of that variable, consult: Harkness and Morley, 'Introduction to the Theory of Analytic Functions,' and 'Treatise on the Theory of Functions.'

Power, in mechanics and physics, the rate at which work is performed; or (what is the same thing), the quantity of work that is performed *per unit of time*. In ordinary engineering practice in the United States and England, the unit of work is the "foot-pound"; a foot-pound being defined as the quantity of work that is performed when a force equal to the weight of one pound of matter is exerted through a distance of one foot. (See MECHANICS.) Nothing is here specified, it will be observed, as to the *time* in which this work is done. A small motor, for example, might require ten seconds to accomplish it, while a more powerful one might perform it in a very small fraction of one second. The work that is performed by a given motor or engine in one second, or in one minute, is therefore the true measure of the "power" that is being developed. James Watt adopted the "horse-power" as the unit of power for steam engines and other large motors, and this has been universally adopted, since his time, in all English-speaking countries. He estimated that a strong horse is capable of performing 33,000 foot-pounds of work per minute; and although it is known that the horse cannot work continuously at this rate, his definition has never been modified, and in steam and hydraulic engineering a "horse-power" is still understood to signify the performance of 33,000 foot-pounds of work per minute, or (what is the same thing) 550 foot-pounds per second. The horse-power of an engine or a water-wheel is therefore determined by observing how many foot-pounds of work it is performing per minute, and dividing this number by 33,000. In the centimetre-gram-second system of units, which is in extensive and increasing use in modern physics, the unit of work is the "erg," and the unit of power is the "watt"; a watt being defined as the power that is developed when 10,000,000 (that is 10^7) ergs of work are performed per second. The watt is employed in practical electrical engineering, as well as in experimental physics; it being then defined as the rate at which work is being done in a circuit in which the current is one ampere, and the electromotive force is one volt. This change in definition is merely a matter of convenience, since it may be shown that the two definitions amount to precisely the same thing. A horse-power is approximately equal to 746 watts.

Consult: Everett, 'Units and Physical Constants.' See also the article UNITS in this encyclopædia.

Power Houses. With the growth of electrical distribution, the generating station has become a highly specialized structure which demands consideration both from the electrical and mechanical view points. In the first instance it presents peculiar requirements as to location, differing widely according to its purpose. Broadly one may divide power houses into two general classes, those designed for the utilization of water power and those using heat engines as prime movers. The former are nearly always power transmission stations connected by high tension lines with the centre of distribution and not themselves burdened with direct distribution of energy to consumers. The latter are generally within the area of distribution, and the centres of distributing net works. In the cases where power is transmitted considerable distances from stations of the second class they are still generally to be regarded as distributing stations as regards the requirements of location.

Location.— The location of hydro-electric power houses is usually determined by purely hydraulic considerations. The area within which they may be economically placed is limited by the topography and the chief requirements are as follows: First, the location must be such as to keep the power house free of floods under all conditions of stream flow. Second, within this limitation the location must be such as to utilize the maximum possible proportion of the available head. Third, in the interest of regulation the station must be placed so that it may be subject to the minimum variation of head. In plants working under high hydraulic heads, high enough to utilize impulse wheels conveniently, these conditions are easily met. At low heads there is often difficulty in placing the power house clear of floods and above any possible backing up of the tail water.

The location of a station driven by heat engines of one sort or another is usually kept as nearly as may be at the centre of the electrical distribution. Since for the delivery of any given load at a fixed percentage of loss the weight of conductor required varies directly with the square of the distance from the load, the reason for a central location is obvious. Assuming, for example, an electrical load uniformly distributed over a circular area, the most economical location of the power station, so far as the conductors are concerned, is at the centre. Transference of the station to a point at the edge of the area approximately doubles the cost of the distributing system. The causes which may justify removal from the central position, are local conditions as to cost of real estate, of fuel, and of water. The first item is part of the capital charge which may be taken as an offset to change in the cost of distribution; the last two affect the operating expense, and the change in these with change of location must be capitalized for comparison with the concurrent change in the cost of distribution.

Fuel.— Fuel is by far the largest single item of expense in ordinary electrical power production, and a power house must be so located, on a railway spur or waterway, that it can receive its supply without incurring serious charges for cartage or other handling of fuel. This necessity usually compels a location somewhat out of the centre of distribution. Water supply is more easily secured, but occasionally it becomes an important factor in location. In cases where the principal office of the power station itself is to furnish energy at high voltage for a distribution from substations, the cost of conductors is relatively a smaller consideration and commonly a location meeting the requirements just laid down can be secured without serious increase in the cost of the conducting system.

Equipment.— The electrical equipment of a modern power station usually consists of a small number of electric generators directly coupled to their prime movers, whether hydraulic, steam, or gas operated. Except in small plants generators driven through intermediary belts, ropes, or gears are rare, since these introduce added complication, cause some loss of energy, cannot well be used for large power, and serve no useful purpose of themselves, save now and then in giving the generators some specially valuable advantage in speed. In such case they should be used without hesitation if the conditions permit. The day of stations equipped with numerous small dynamos has passed, and for good cause, since the small machines are more costly and less efficient for a given total output, and they require also more space and more care.

Hence the number of generating units should generally be reduced to the minimum that will satisfy the following condition, viz.: that the total number should be such that one unit can go out of service without seriously overloading the others, dividing its load among them. Good modern generators usually are able to carry 25 or 30 per cent. over their normal rated loads for some hours without serious heating, so that ordinarily four or five generators suffice. If the load upon the plant is normally moderate, two or three generators may serve admirably until such time as the normal full load nears the rated capacity of the machines. On the other hand more than five or six generators are seldom advantageous unless the total capacity of the power house is very large, so large that it cannot readily be derived from so few generators.

As generators are now often made of 5,000 to 10,000 kilowatts output, the case just mentioned is unlikely to arise save under the following conditions. First, in a hydro-electric plant at low head the available wheel speeds for units of the size mentioned may be so low as to demand a generator of very disadvantageous design. When this case arises it is often better to split up the plant into smaller units, the gain by so doing more than compensating the loss. Second, it may be necessary in the same power house to install generators for serving several quite independent lines, or for radically different kinds of service, as for furnishing both alternating current and direct current. Then the number of machines for each service must be determined in the way just noted, and the total number will be considerably increased.

Broadly, however, large stations should differ from small ones only in the capacity of individual units, so that if a 2,000 kilowatt plant is equipped with four 500 kilowatt units, a 20,000 kilowatt plant would be equipped with four 5,000 kilowatt units. In either case the same allowance for reserve capacity would naturally be made, but evidently the larger plant would have the advantage not only of greater economy in the larger units but of reduced attendance cost per unit of output, and would also cost less per unit of output.

Large power plants then evidently can produce electrical energy at a lower cost than small ones. As the size is increased, however, the relative gain is diminished so that a size will finally be reached at which further increase in capacity ceases to be beneficial. Indeed since a very large station usually implies a large area served, the average distribution losses will be reduced by serving it from several interconnected power houses, so that the maximum economical capacity of a single power house is less than would be determined by considering only the effect of size on fuel and labor.

For example, if a certain district requires 100,000 kilowatts, it is altogether probable that two 50,000 kilowatt plants will serve it more economically than a single gigantic power house, and unless the district is of moderate area, four 25,000 kilowatt stations would probably do even better, provided they could all be well located. In other words a power plant of 25,000 kilowatts or thereabouts comes so near to giving maximum economy of operation that the difference is easily offset by lessened losses in distribution. The only cases in which size may be economically increased without limit are those in which the plants must for one reason or another lie far without the area served, as in great hydro-electric plants like those at Niagara or in plants using coal at the mines for transmission of power on a colossal scale.

In any power house adequate provision for reserve capacity evidently can be most easily made if the equipment throughout is of a single kind so that everything may be as far as possible interchangeable. Similar units of uniform size are therefore advisable throughout the entire plant unless there is some good reason to the contrary.

The equipment of a power house may be divided into four parts: the prime movers, the electric generators, the accessory apparatus, and the switchboard from which the output is regulated and distributed. The power house structure must be planned for advantageous location of all of these, and in addition, if steam is the motive power, there must be ample provision for the storage of fuel.

Design and Arrangement.— In point of design hydro-electric power houses present by far the simplest problem. In these the prime movers are the water wheels which are relatively simple and compact, the generators are directly coupled to the shafts of these, and the output is delivered to a small number of lines so that the switchboard is relatively simple. As most such plants are for high voltage, the power house must often provide place for the transformers which raise the voltage from that of the generators to that of the line. Less frequently such transformers are found in steam-driven plants.

Structurally the ordinary power house consists of two parallel halls with a common dividing wall, one containing the generating units, the other water wheels or boilers as the case may be. The generator room contains, or has annexed to it, space for the switchboard connections and for the transformers, if any, while the boiler or wheel room has annexed to it space on the one hand for fuel, on the other for the hydraulic connections. Usually the plant comprises only a single story, although more rarely ground space is gained by superimposing some of the parts.

One may now pass to consideration of the concrete arrangements usually adopted, the hydro-electric case being taken up first, as the simpler in design.

Fig. 1 shows the ground plan of a typical hydro-electric power station using as prime movers water wheels under high head. Here A is the receiver terminating the supply pipe and provided with branches to the several wheels. At very high heads these branches are sometimes made farther back spreading finger-wise from a terminal chamber to secure a straighter run to the wheels. B, B, B are the water wheels, directly coupled to and on the same level with the generators C, C, C. The pipes from the water supply enter the lower part of the wheel cases and discharge into the tail race below the power-house floor. The wheel gates are controlled by the governors D, D, D. The generators are revolving-field, 400 kilowatts, three-phase machines, giving 13,000 volts at the terminals at 500 revolutions per minute. Their fields are excited by two 25-kilowatt direct-driven exciters, E.E., each of which is regulated by a separate hydraulic governor. The switchboard is located on the floor level at F, and the line wires leave the power house just above and behind the switchboard. Room is provided for a fourth generator, and a traveling crane running lengthwise the power house is available for handling the machinery if necessary. The material of this power house is brick, on concrete foundations, with a steel truss roof covered with reinforced concrete slabs and then with roofing felt and asphalt, as the location is in a cold climate.

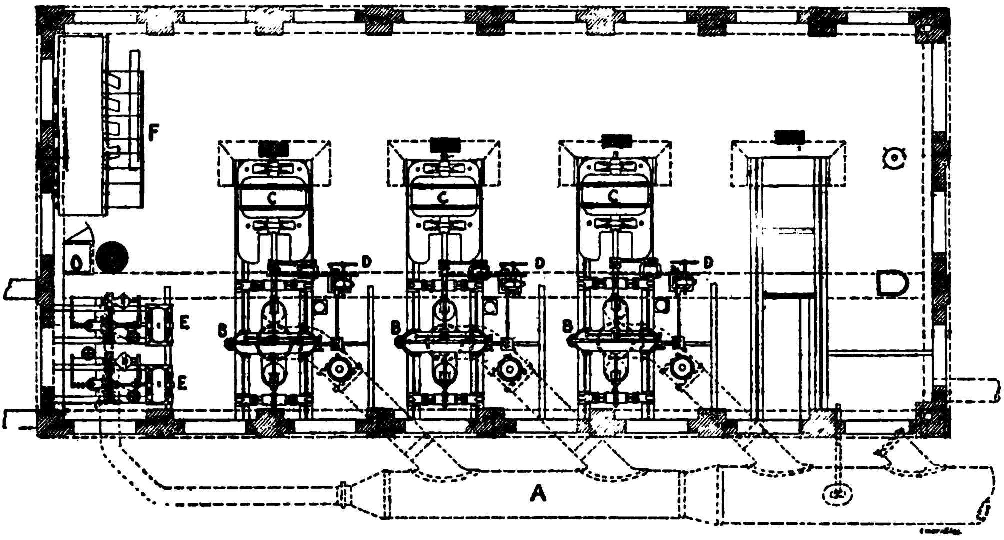


Fig. 1.

The design here followed is thoroughly simple and normal. At higher hydraulic head the somewhat unusual turbines here used would be replaced by impulse wheels in the same situation; at lower head by considerably bulkier turbines which would require a wider tail race and power house for their accommodation. In this case the inner tail-race wall would usually carry a partition wall separating the wheel room from the dynamo room proper and provided with water-tight fittings for the turbine shafts to pass through.

In case raising transformers were to be used in such a plant the generators would be for perhaps 2,000 volts, the switchboard would preferably be turned around, facing the exciters, and the station would be extended far enough to the left of the cut to accommodate the transformers and the necessary accessories; or, if more convenient from the nature of the ground, space could be gained by widening the power house enough to accommodate the row of transformers. The size of the power house of Fig. 1 is about 40′ x 85′, and slight modifications of this simple design serve well up to very much larger capacities. In case the necessary width becomes too great to be conveniently covered by a single roof, separate roofs are placed over the wheel rooms and generator rooms, and in mild climates the wheel cases and tail race may sometimes be left uncovered.

It is necessary even in hydraulic plants to make the power station as nearly fireproof as possible and hence brick, steel, and concrete are the most suitable materials of construction. Wood, even if treated by some fireproofing process, should be sparingly employed. For floors concrete, reinforced when necessary, is probably the best material. The transformers and switchboard are the danger points, from the standpoint of fire risks. The former should be placed so that even if they burn out no exterior damage will result. If, as is usual in high voltage plants, they are oil-insulated, provision should be made for disposing of the oil harmlessly in the rare case where it ignites from an extreme short circuit. Transformer oil is very difficultly inflammable, but it can be fired, and oil transformers should be guarded by pits with drains, so that the oil may not run about if it escapes from the cases. Sometimes the transformer cases are provided with drain valves from which the oil can be quickly run off outside the station.

The connections between generators and switchboard are generally made by cables laid under the floor in tile ducts, so as to keep the overhead space free for the crane. The higher voltage wires from the transformers should be gotten out of the building by a very short route overhead or through very capacious ducts. In any case great care should be taken to locate all cables carrying heavy currents where a burn-out of one will not involve others.

In very large stations, both hydro-electric and steam driven, the switchboard is frequently placed in a gallery overlooking the generator room. This position is in itself undesirable as adding enormously to the complication of the wiring, but in very large stations sometimes becomes advisable. In such case the larger switches are not manually operated, but are worked by electric or pneumatic power controlled from the switchboard. The switches themselves are then located under or behind the gallery, and are commonly oil insulated and inclosed in masonry or concrete cells. With three or four generators and one or two main lines to be fed the switchboard is sufficiently complex, but when in addition numerous feeding lines must be controlled the complication becomes something frightful and a large amount of space is required for the switching apparatus, so large and so subdivided for safety that manual control is practically out of the question. In large high voltage power stations the transformers are sometimes in a room entirely separated from the main station and provided with an independent high voltage switching equipment, a procedure which probably adds nearly as many risks as it avoids. On the whole a plant with few units and relatively simple equipment is likely to give the most reliable service at the lowest cost.

Steam-driven stations are very differently proportioned owing to the great space necessary for boilers and their accessories. Fortunately the boiler equipment can be stowed without much waste space, but it is a curious thing that while the engine units have increased very greatly in capacity in recent years, the boiler units remain almost unchanged, so that one may find a single direct-connected generating fed by perhaps half a dozen boilers. Fig. 2 shows a typical steam-driven plant in elevation. Here the boilers are arranged in a single row at A, the smoke flues with economizers are at B, discharging into the stack C, which rises near the centre of the station. The engines are at D and a low basement E contains condensers, pumps, and so forth. Beyond, an addition in three stories is built out for the switchboard and accessories. There are three generating sets in this particular station each rated at 750 kilowatts, and eight boilers arranged in pairs. Two engine-driven exciters furnish field current, since the generators here, as very often in recent power houses, are polyphase machines at high voltage, in this instance 13,000 volts. In plants where economy of space is important the type of engine chosen is frequently the vertical cross-compound, instead of the horizontal tandem compound found here, and in such case the switchboard would be located in the generator room itself, arranged much as shown. In most American stations of recent design the fuel is fed to the furnaces by automatic stokers, which, upon the whole, do the work more uniformly and economically than it can be done by hand firing, especially where using low-grade coal. The fuel is also commonly brought by automatic conveyers into the pockets from which the stoking apparatus is supplied. In an increasing number of cases, too, the tall chimney common to power houses is replaced by a low stack and the furnaces are worked by artificial draft furnished by a blower. This device has the advantage that it enables the furnaces to be hard driven at times of specially severe load. At moderate and uniform load its economy is rather dubious, but in certain power plants which are subject to periodical overloads the artificial draft has proved advantageous.

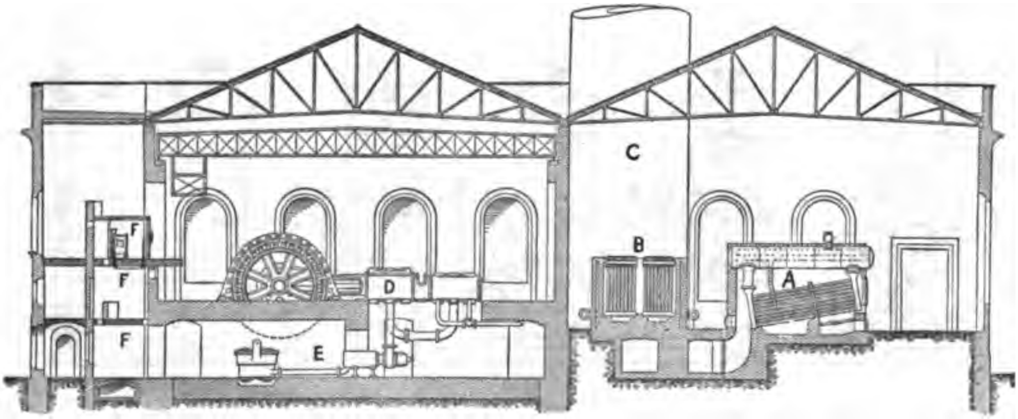
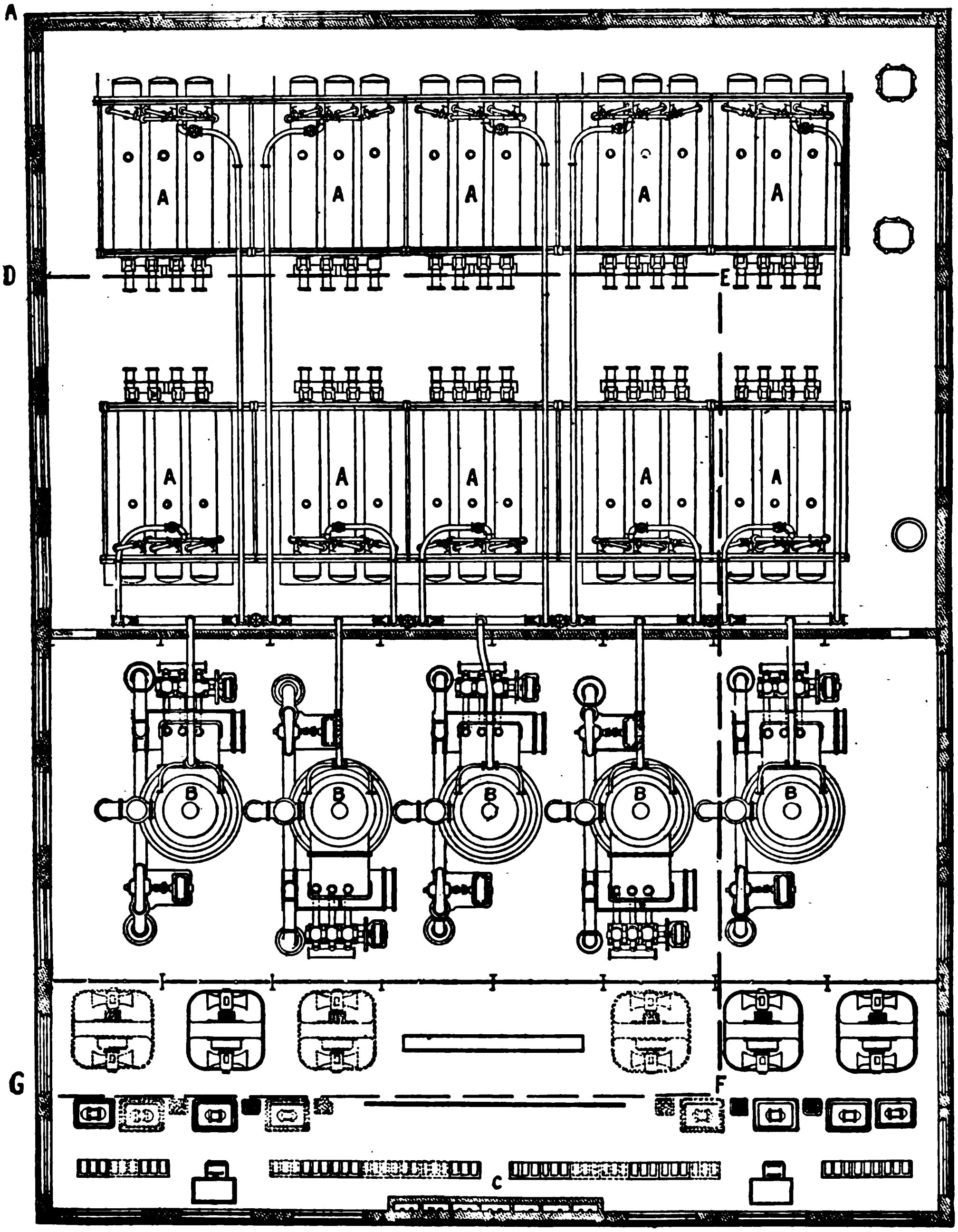


FIG. 2.—TRANSVERSE SECTIONAL ELEVATION OF POWER-HOUSE.

The greatest recent change in power-house design has come through the introduction of the steam turbine. As this machine normally runs at a rotative speed eight or ten times as great as that of a reciprocating engine of similar output, both turbine and generator are of large output for their dimensions. Many recent turbo-generators are made with vertical shaft, the generator being superimposed upon the turbine, and the weight being carried by a water-step supplied by a pressure pump. Thus arranged a 5,000 kilowatt turbo-generator will go into a space about 20′ x 20′, and has a height over the foundation of about 30′. Were this the only thing to be considered the generator room of a power plant thus equipped could be reduced to absurdly small dimensions, but the steam turbine for the best results requires a surface condenser to give at least 28″ vacuum, together with its pumps and accessories. An attempt to crowd the turbines closely together also leads to inconvenience in the steam piping in large plants, which must still contain long rows of boilers, so that the full apparent economy of space is seldom realized. As the turbines give an efficiency quite comparable with that of compound condensing engines under the usual conditions of pressure and superheating, and at light loads do relatively rather better, they have come to be very extensively used in power houses of recent design.

Fig. 3 shows a plan of a typical turbo-generator station. As it is for electric railway service the generator room is widened to permit the installation of a row of rotary converters with their transformers. In other respects the design is entirely normal and a very good example of its kind. Fig. 4 shows the elevation of the same station. The batteries of boilers are lettered A, the turbo-generators B, and the switchboard space C. There are five 2,000 kilowatt turbo-generators, and 10 boilers arranged in two rows with the firing floor between them. As in nearly all recent stations the boilers are of the water-tube sort, generally chosen for its comparative immunity from explosion and its ability to respond easily to a call for forced output. As a glance at Fig. 4 shows, there is a large coal pocket over the firing-floor fed by automatic conveyors, and itself feeding the automatic stokers through a series of chutes. The ash is also automatically delivered to the chutes immediately beneath the firing floor, and falls into ash cars in the basement. This basement



Street Ry Journal

Fig. 3.

also accommodates the engine-driven blowers for the forced draft. These arrangements reduce the labor expense to a minimum and render the boiler room exceedingly compact.

The generator room, owing to the vertical turbines, is also compact, but considering the area required for condensers and pumps the gain in space is rather less than the dimensions of the turbines would suggest. The ability of the turbine to run on comparatively slight foundations

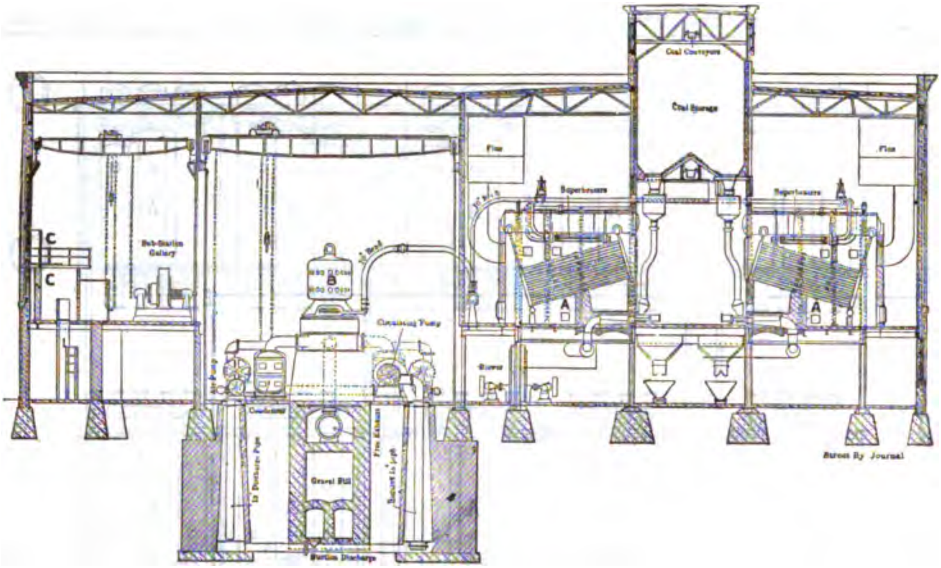


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FIG. 4.

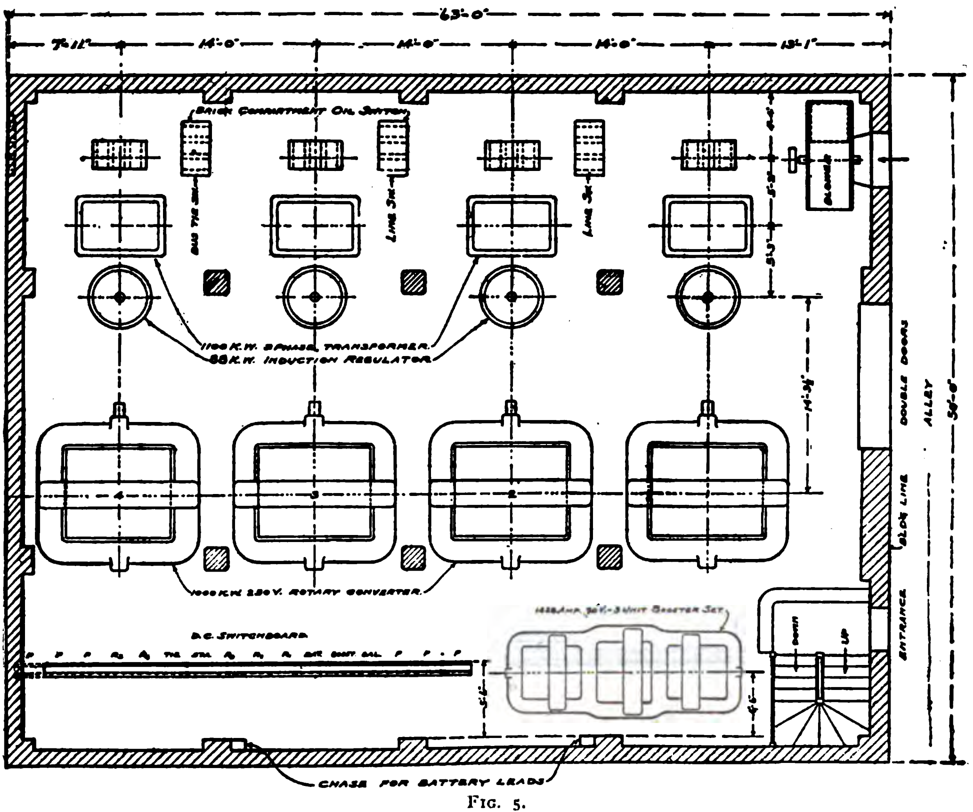

FIG. 5.

is, so far as station design is concerned, more valuable than the gain in floor space.

The exciting current for the turbo-generators is furnished by two engine-driven and two motor-driven exciters, but later types of turbines have exciter armatures on their own shafts, so as to be entirely self-contained. It will be noted that the placing of the boilers in two rows is necessary to take advantage of the compactness of the turbo-generators. This is also the case when large vertical engines are used and is a result of the relatively small capacity of individual boilers. With turbo-generators of smaller capacity, say 750 kilowatts each, the station plan would be somewhat as indicated by the dotted line D E F G, and the relative arrangement of parts would remain about the same. The station here shown is situated on tide water so that sea water is available for condensation and the coal is unloaded by machinery directly from the vessel. The building is 161′ x 121′ and has, therefore, a little less than two square feet of area for each kilowatt of generating capacity, a fair figure for a large station. If real estate is costly further space can be saved by double decking the station as far as possible. Some stations have been built, for instance, with two stories of boilers, and by such devices and the use of large generating units, the ground space can, if necessary, be brought to or a little below one square foot per kilowatt. It is doubtful, however, whether so great striving for compactures is good policy save in very rare instances.

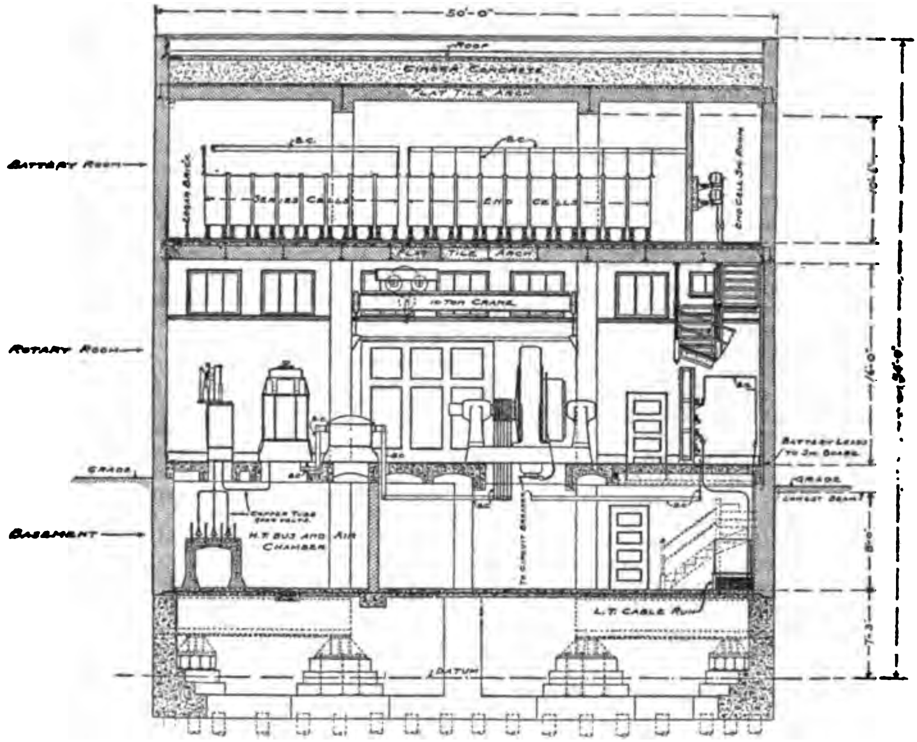

Fig. 6.

Sub-Stations.—An account of power houses would be incomplete did it not take notice of sub-stations. The modern power house is almost always fitted with alternating current generators which transmit current either for general distribution or for conversion into direct current for supplying electric railways or the old direct current lighting systems. Such conversion must probably be regarded as a makeshift, but at present a necessary one. The high voltage current from the power house is transmitted through cables or over aerial lines to the sub-stations, and there the voltage is lowered by reducing transformers to the amount appropriate for the rotary converters, generally not far from two-thirds of the derived direct current voltage. The sub-station must, therefore, accommodate the reducing transformers, the rotary converters, regulating apparatus, switchboards for both alternating and direct currents, and sometimes a storage battery and its accessories. The structure, therefore, becomes practically a power house for general service, less only the prime movers. Figs. 5 and 6 show in main floor plan and elevation a recent sub-station for city lighting and power service which is a masterpiece of compactness. It is a modern steel building two stories above grade and with a basement for the cable entrances and exits. The main floor contains, as Fig. 5 shows, arranged in order, the high-tension bus and main switches, the three-phase transformers, the regulators, and the rotary converters, of which there are four, each of 1,000 kilowatt capacity. The same room contains the booster set for charging the batteries at a variable voltage somewhat higher than that of the rotaries, and the switchboard, also a blower set for ventilation. Large apertures are left under the rotary converters and transformers so that a liberal air supply may be drawn in from below and exhausted by the blower. The second floor contains the storage batteries and their special switching arrangements. On account of possible leakage of acid from the batteries the floor construction is peculiar. The basis is tile arch over steel beams. Then comes a layer of concrete coated with asphalt, then a floor of hard-baked brick, glazed all over, laid with narrow interstices which are finally filled with hot asphalt.

Sub-stations for railway service do not usually have the storage battery, and are generally less compactly arranged, but after about the same general plan. The sub-station shown here covers only 3,150 square feet for its 4,000 kilowatts capacity. Ordinarily the switching arrangements in a sub-station are so intricate as to require a rather liberal allowance of space. The same principles of location and subdivision of units hold for sub-stations as for power houses in general, with the advantage that the location is not dependent on water and fuel supply. Sub-stations for the receiving ends of power transmissions for general service differ from those just described in the lessened importance of rotary converters. The ordinary distribution from a high voltage transmission service is very largely by alternating currents, and is accomplished by sub-stations designed accordingly. The high voltage current is received in large reducing transformers which in number, size, and location are to be treated as so many alternating current generators fortunately exempt from the necessity of rotation. Regulating apparatus is an important feature of stations of this class, and being inductive can be applied with very small loss of energy to the exact regulation of voltage on individual feeders.

For arc light service constant current transformers are very widely used, taking energy from the lower voltage side of the reducing transformers. This service requires a special switchboard, and is generally set apart in the sub-station. Owing to the absence of rotating machinery in any considerable amount the sub-station for general service is compacter and requires less in the way of foundations and special construction than the sub-station of Fig. 5. Otherwise the principles of location and design are unchanged. LOUIS BELL,

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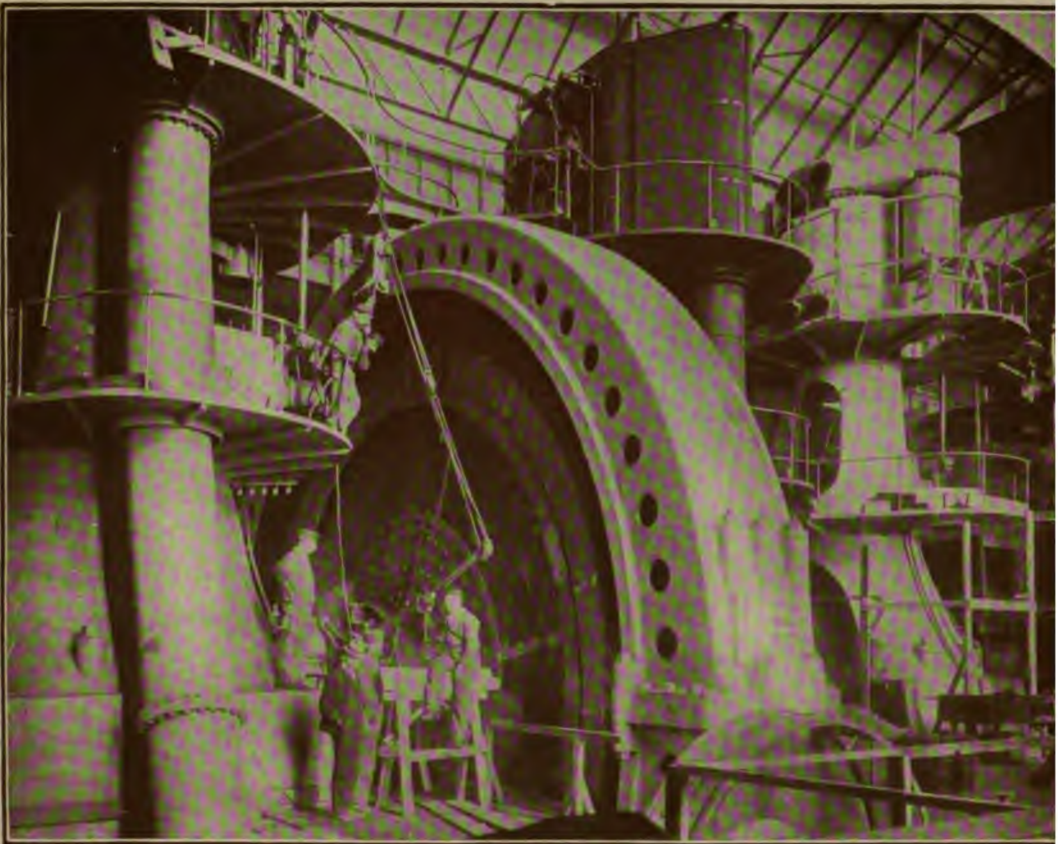
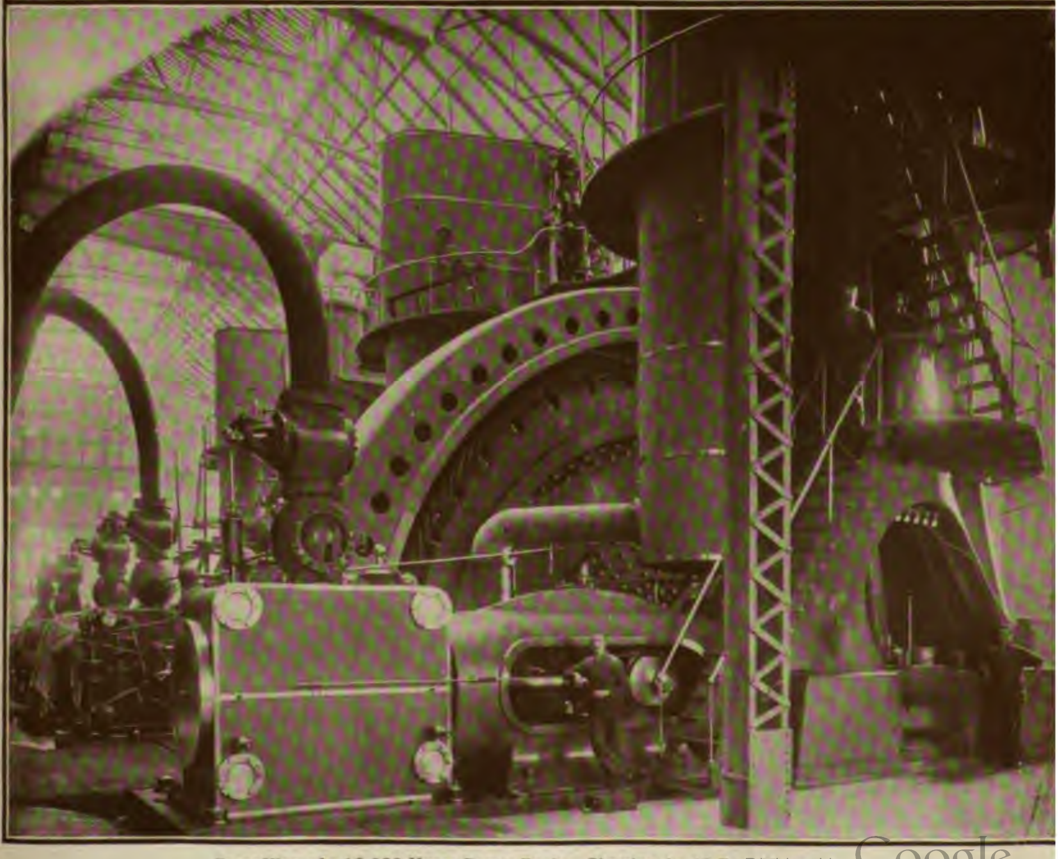
Power, Transmission of. In mechanical engineering problems are continually arising which involve the transmission of power from one part of a machine to another, or from one machine to another machine, or from one locality to another locality that is perhaps at a considerable distance. Between the different parts of a given machine, or of a given mill, the transmission is often effected by means of a rotating shaft, which is subjected to a torsional moment. In mill work the shaft is rigid, and is made of solid steel, or of steel tubing; while in small machines (as in dental drills and the like) the shaft is often flexible, so that the point of application of the power can be varied at will, without disturbing the source from which the power is drawn. In mill practice it is essential that the alignment of the shafting shall be as good as possible,— that is, that the centre line of each shaft shall be as nearly straight as it can be made. It is also essential that the «journals,» or bearings which support the shaft, shall be properly designed, and well lubricated. If attention is paid to these points, transmission by shafting may be quite efficient; but if the alignment is poor, or the journals are poorly designed, or the lubrication is inadequate, a great deal of energy may be absorbed by the shaft, and dissipated in the form of frictional heat.

In transmission by shafting, the speed remains invariable, and if (as is usually the case) a change of speed is desired, it must be effected by the use of gearing or belting, or some similar device. The efficiency of transmission by gearing depends very largely upon the perfection of the gearing, and it falls off rapidly when the teeth of the gear-wheels begin to show the effects of wear to any material extent. According to data given by Lewis, the efficiency of a pair of good spur gears may range from 90 to 98 per cent, the former result being given for a velocity, at the pitch line, of 3 feet per minute, and the latter for a velocity of 300 feet per minute.

Belting is employed more commonly than gearing, for transmitting power from one shaft to another. The resistance of a belt to slipping is independent of the width of the belt, so long as the total stress upon the belt is constant. It depends chiefly, in this case, upon the arc of contact between the belt and the pulley; and a belt will slip just as readily upon a pulley four feet in diameter as upon one that is two feet in diameter, if the arc of contact (measured in degrees) is the same in both cases, and the surfaces of the two pulleys are in the same condition. The laying out of a successful system of belting, for use in mill work, calls for a considerable amount of practical experience with belts, since it must be admitted that many of the formulæ that have been given do not correspond satisfactorily with experience. It was formerly taken for granted, for example, that the sum of the tensions on the two sides of a belt remains constant, the only effect of running the belt being to increase the tension on one side of it, and to simultaneously decrease the tension on the other side by an equal amount. Lewis and Bancroft found that this is not the case; and hence any formula which assumes it to be true must be regarded as inaccurate. Webber gives the following practical rule for ordinary leather belting of single thickness: A belt one inch wide will safely transmit one horse-power, when run at a speed of 600 feet per minute; and the power transmitted will be proportional to the width of the belt, and to the speed at which it is run. This rule gives no information with regard to the proper tension; but it implies that the tension may be safely increased until the belt actually does transmit the computed horse-power. (Consult Cooper 'Treatise on the Use of Belting,' and also Kent, 'Mechanical Engineer's Pocket Book.') Wire ropes, as well as ropes of hemp, cotton, or raw-hide, are now employed to a considerable extent in the place of belts, when large amounts of power are to be transmitted. The principles involved are similar to those which apply to ordinary belting, but the ropes, instead of passing





Front View of a 12,500 Horse Power Engine, Showing the 42-Foot Alternator.

100,000 H. P. POWER STATION.—SIDE VIEW, SHOWING THE HORIZONTAL HIGH-PRESSURE CYLINDERS AND THE COMPLETE ENGINE.

over smooth pulleys, run in grooves that are turned in the pulleys. (Consult J. J. Flather, 'Rope Driving.')

Compressed air is employed in the transmission of power in many cases, especially in the operation of rock drills, and in mining generally, the air serving, in such cases, not only to operate the machinery, but also to aid in the ventilation of the mine. The compressed air may be delivered to the point at which the power is wanted by means of pipes directly from the compressors, or it may be stored at high pressure in tanks, from which it is drawn as wanted. Locomotives are used in mining, for example, which derive their power from large tanks of compressed air that take the place of the ordinary steam boilers of other locomotives; these tanks being charged at convenient points along the line of travel. Power is also transmitted hydraulically, when, as in cranes, presses and elevators, it is desired to exert great force in some slow-moving piece of machinery.

A great deal of attention has been given, in recent years, to the economical transmission of power by electricity, and the various problems that are involved have been solved so satisfactorily that enormous quantities of power are now transmitted electrically, in some instances to a distance of from 50 to 75 miles. The mechanical energy that is to be transmitted is first converted into electricity by means of a dynamo; and the electricity thus generated is led along a conductor (usually of copper) to the point where the power is to be used, it being there re-converted into mechanical energy by means of electric motors. In certain shops and mills, the power is transmitted in this way from the engine room to the various machines that are to be operated, each machine being provided with its own separate motor. Installations of this kind are especially successful when the work is of such a nature that the machines are idle for a considerable part of the time, because there is no loss, in electrical transmission systems, when the circuit is interrupted and no current is flowing; whereas in a mill that is fitted up with shafting and belts the shafting runs all the time, and the losses due to its friction go on all the time, whether the machines are running or not. The use of individual motors, as described, is also advisable in plants where the machines are run at high speeds, since the desired speeds can be attained electrically, without the losses incident to the use of pulleys and belts, of trains of gears, or any other method of direct mechanical multiplication.

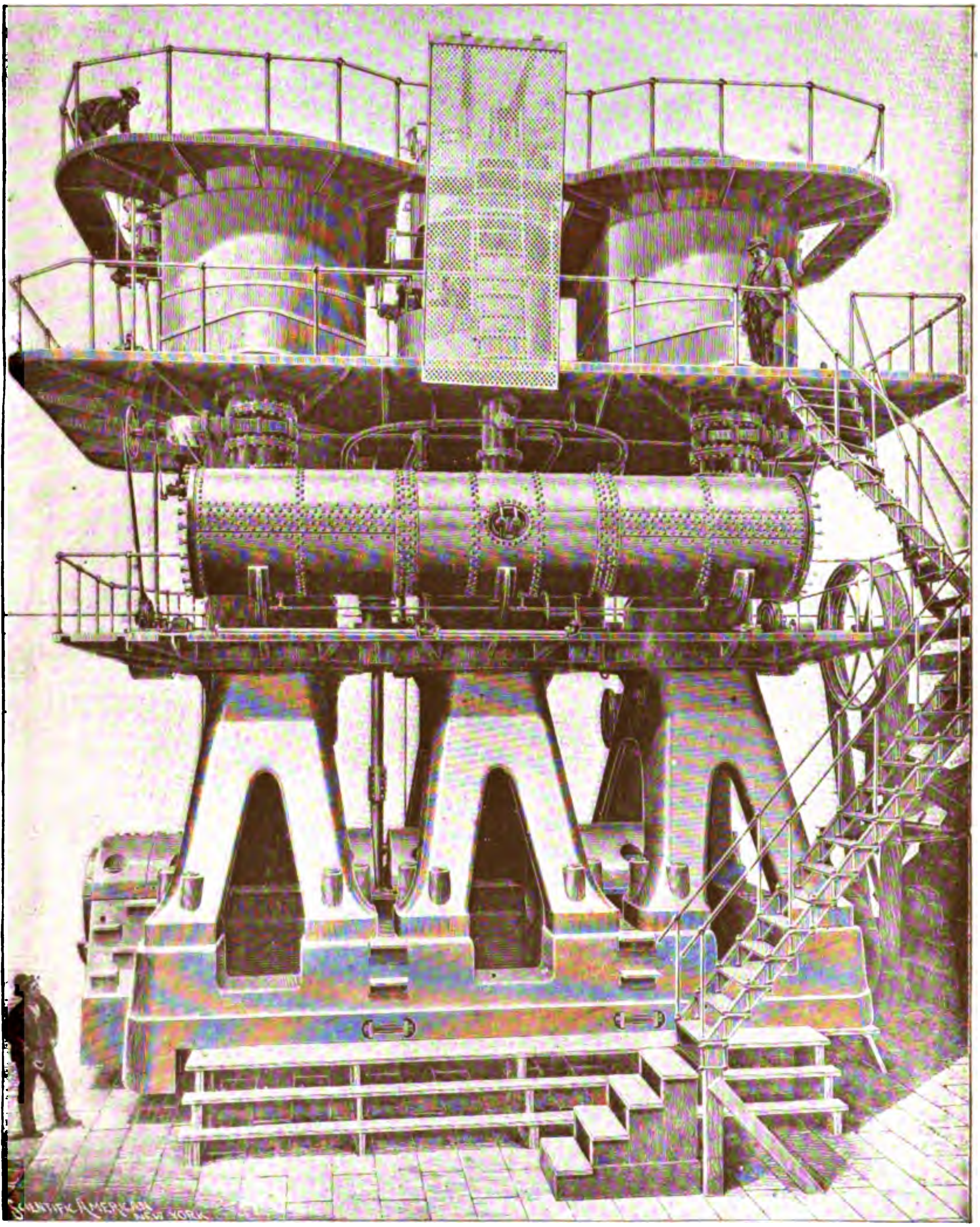
In the transmission of power by electricity to considerable distances, the chief losses are those due to direct leakage of electricity along the line, and to the dissipation of energy in the form of heat in the conductor. The losses due to the former cause can be kept down to a reasonable limit by paying proper attention to insulation, though the problems that are here involved are very serious, when the potential of the conductor is maintained (as is often the case) at 10,000 volts or over. The loss due to the development of heat on account of the resistance of the conductor can theoretically be diminished as much as we please, by merely increasing the size of the conductor; but conductors sufficient in size to render the heat loss negligible are too expensive to be commercially practicable. Lord Kelvin, in an attempt to determine the most economical size of conductor for electrical transmission, came to the conclusion that the maximum economy is attained when the conductor is of such a size that «the annual interest on the capital outlay is equal to the annual cost of energy wasted.» Under ordinary conditions, this is found to lead to the conclusion that the most economical current-density in the conductor is about 380 amperes per square inch of sectional area of the conductor. For the case in which a given horsepower is to be delivered at a given distance, the condition is somewhat different, and not so simple. Professors Ayrton and Perry, who have investigated this case, have given somewhat complicated formulæ for determining the most economical cross-section of the conductor. (See Kent, 'Engineer's Pocket Book,' and the references there given.) In long distance transmission it is customary to adopt, for the transmission line, a far higher potential than is desired for the operation of the machinery at the delivery end, since this artifice makes it possible to transmit a given quantity of electrical energy over a given conductor with a smaller heat loss than would be involved if the transmission were effected at a lower potential. When the transmitting current is alternating, the reduction of potential at the delivery end may be effected by means of a transformer; but when the transmitting current is direct, it is customary to employ a «motor-generator,» which consists of a motor, actuated by the transmission current, coupled on the same shaft with a dynamo, which gives out a current adapted to the work to be done. The motor-generator is also used to transform an alternating transmission current into a continuous current, when the continuous current is desired for delivery purposes. Some of the problems of electrical transmission have been solved on a very large scale at Niagara Falls, where the water power is now partially utilized for mechanical purposes. A portion of the power that is developed in the turbine houses is transmitted electrically to Buffalo, for the operation of electric railways and for other purposes, and the remainder is utilized, also in the electrical form, in factories in the more immediate neighborhood of the falls. The longest electrical transmission line in the United States extends from Redlands, Cal., to Los Angeles, a distance of about 80 miles.

For the general principles governing electrical transmission, consult Kapp, 'Electric Transmission of Energy'; see also Perrine, 'Conductors for Electrical Distribution.'

Power, Utilization of. The economical production of manufactures and the convenient adaptations of time- and labor-saving devices in all the various lines of constructional work have exerted a wonderful influence in the upbuilding of American industries. Among other significant features the present tendency is marked by the adaptation of compressed air and the application of electric power to machine driving. In the use of compressed air, the facility of adaptation to various requirements which are in many cases additional to the supply of motive power, is a valuable feature peculiar to this system and one which is susceptible of extension along many lines. The labor cost in most machine shops and other works is so much greater than the cost of power that any expedient by which the labor cost may be appreciably reduced is justified, even though the efficiency of the agent itself be low. Whenever new methods or agencies cause an increased production with a given outlay for labor, we shall find these methods superseding the old, even though the cost of the power required be greater than before. The saving of power is a consideration secondary to the advantages and economical output obtained by its use. While economy in the use of power should therefore be secondary to increased output, yet careful attention to details will often greatly reduce the useless waste of power. Engineers have recognized that there is a very great percentage of loss due to shaft friction, which, in railroad and other shops where the buildings are more or less scattered, may be as great as 75 or even 80 per cent of the total power used. In the ordinary machine shop this loss will probably average from 30 to 50 per cent. No matter how well a long line of shafting may have been erected, it soon loses its alignment and the power necessary to rotate it is increased.

Power Waste.— Manufacturers are realizing the loss of power which ensues from the present system of transmission, and we find a general tendency to introduce different methods by which a part of this loss will be obviated. Among these are the adoption of hollow and lighter shafting, higher speeds and lighter pulleys, roller bearings in shaft hangers, and the total or partial elimination of the shafting. Independent motors are often employed to drive sections of shafting and isolated machines, and among these we find steam and gas-engines, electric motors, compressed air and hydraulic motors, although the latter have not been used for this purpose to any appreciable extent. In the choice of motors, until quite recently the steam-engine has heretofore been used, especially where the units are relatively large. An interesting example of this is noted in the sugar refinery of Spreckels, in Philadelphia, in which there are some 90 Westinghouse engines about the works, many of them being of 75 and 100 horse-power each; others of 5 and 10 horse-power only. A similar subdivided power plant involving 42 engines was erected several years ago at the print works of Dunnell at Pawtucket, R. I. It was only a comparatively few years ago when several large and economical Corliss engines were replaced at the Baldwin Locomotive Works by a greater number of small, simple-expansion engines, which actually required about 15 per cent more steam per horse-power hour than the Corliss engines. This loss, however, was only apparent, for by increasing the number of units and locating them at convenient centres of distribution much of the shafting and belting could be dispensed with and an actual saving of power was obtained. Later, these simple engines were replaced by a number of compounds, some 18 being in service; subsequent tests on these showed a saving of 36 per cent over that obtained by the use of the simple engines. More recently, however, the electric motor (q.v.) has superseded the steam-engine for this work, as its economy and convenience over the latter are now thoroughly recognized.

Electric Power.—The statistics of American manufacturing, compiled by T. C. Martin for the United States Census Office, show that at the time of the last census (1900) electric power was less than 5 per cent of all that was in use in such plants, or about 500,000 horse-power out of a total of 11,000,000; but, as Mr. Martin states, things are to be judged by tendencies rather than by the *status quo*, and these electric motor figures exhibit an increase of 1,900 per cent during the decade. The introduction of electric power in machine shops and factories was at first looked upon with disfavor and was opposed by many manufacturers, but the innovation obtained a foothold, and advantages which were at first unforeseen were found to attend its use, so that now it is being very generally adopted for a wide variety of work. A considerable difference of opinion exists as to whether individual motors should be used with each machine, or whether a number of machines should be arranged in a group and driven from a short line shaft. There are well-defined conditions to which each system is best adapted, but there are wide limits between which there appears to be no general rule, and we find both methods occupying the same field. For isolated machines and for heavy machines that may be in occasional use, the individual motor is particularly well adapted, as it consumes power only when in operation. It is, however, necessary that each motor thus connected shall be capable of supplying sufficient power to operate its machine under the heaviest as well as lightest loads. In certain cases, moreover, the load is liable to very great irregularity, as for instance in metal-working planers, in which the resistance offered by the machine at the moment of reversal of the platen is far higher than at other times, and may be so great as to endanger the armature of the motor. Under these conditions it is necessary to use a motor of much larger capacity than the average load would indicate. Ordinarily in machine driving the motor is shunt-wound, and the current through the field coils is constant under all conditions of load; but to obtain the best results with that class of machinery in which the load is intermittent and subject to sudden variations, the motor should be compound-wound so as to increase the torque without an excessive increase of current in the armature. In many cases with individual motors, owing to wide variations in power required, the average efficiency of the motor may be very low; for this reason a careful consideration of the conditions governing each case indicates that for ordinary machine-driving, especially with small machines, short lengths of light shafting may be frequently employed to good advantage, and the various machines, arranged in groups, may be driven from one motor. By this method fewer motors are required, and each may be so proportioned to the average load that it may run most of the time at its maximum efficiency. When short lengths of shafting are employed the alignment of any section is very little affected by local settling of beams or columns, and since a relatively small amount of power is transmitted by each section, the shaft may be reduced in size, thus decreasing the friction loss. Moreover, with this arrangement, as also with the independent motor, the machinery may often be placed to better advantage in order to suit a given process



THREE-CYLINDER COMPOUND ENGINES OF THE NEW YORK EDISON POWER STATION.

One high-pressure cylinder 43½ inches diameter: two low pressure, 75½ inches diameter: stroke, 5 feet.

of manufacture; shafts may be placed at any angle without the usual complicated and often unsatisfactory devices, and a setting-up room may be provided in any suitable location as required, without carrying long lines of shafting through space. This is an important consideration, for not only is the running expense reduced thereby, but the clear head-room thus obtained, free from shafting, belts, ropes, pulleys, and other power-transmitting devices, can be more easily utilized for hoists and cranes, which have so largely come to be recognized as essential to economical manufacture.

Distribution.— In arranging such a system of power distribution the average power required to drive is of as much importance as the maximum, for in a properly arranged group system the motor capacity need not be the equivalent of the total maximum power required to operate the several machines in the group, but may be taken at some value less than the total, depending upon the number of the machines and the average period of operation. On the other hand, as already shown, the motor capacity of independently driven machines must not only equal the maximum power required to drive the machine at full load, but it must be capable of exerting a greatly increased momentary torque. In any case large units should be avoided, for the multiplication of machines driven from one motor entails additional shafting, counter-shafts, and belting which may readily cause the transmission losses to be greater than those obtained with engines and shafting alone, besides frustrating some of the principal objects of this method of transmission.

As far as the efficiency of transmission is concerned, it is doubtful whether, in a large number of cases, motor-driving *per se* is any more efficient than well-arranged engines and shafting. As already pointed out, the principal thing to be kept in mind is a desired increase in efficiency of the shop plant in turning out product, with a reduction in the time and labor items, without especial reference to the fuel items involved in the power production. On account of the subdivision of power which results from the use of many motors, there is less liability of interruption to manufacture, and in case of overtime it is not necessary to operate the whole works, with its usual heavy load of transmitting machinery. Another advantage is the adaptability to changes and extensions; new motors may always be added without affecting any already in operation, and the ease with which this system lends itself to varying the speed of different unit groups is a very potent factor in its favor. When power is delivered to the machine by direct connected motors, a serious difficulty is often experienced in obtaining speed variation, which is so necessary with a large proportion of the machines in common use. A certain amount of variation can be obtained by rheostatic control — a wasteful method; or by using a single voltage system with shunt field regulation; but the variation in either case is very limited. This, however, may be increased by using a double commutator if space will permit. The three-wire, 220-volt system, offers many advantages for both power and lighting systems, and is very frequently employed. Variations of speed may be obtained with this system by using a combination of field regulation with either voltage, and, in rarer cases, by the use of a double commutator motor. A method which has been used recently with considerable satisfaction involves the use of a three-wire generator, with collector rings connected to armature winding similar to that of a two-phase rotary converter. Balancing coils are used, and the middle points of these are connected to the third wire, which is thus maintained at a voltage half way between the outer wires. This system is simple and economical, and possesses all the advantages of the ordinary three-wire method; it permits similar variations in speed by field regulation with either voltage; and if still wider ranges are desired a double commutator motor may also be used.

In other recent installations the four-wire multiple voltage system is used, which permits of very wide variations of speed in the operation of the tool. This system gives excellent results and removes one of the objections urged against direct-connected motor-driven tools, namely, that such machines are not sufficiently flexible in regard to speed variation, and that such variation can only be obtained by throwing in resistances which cut down the efficiency of the motor, or by varying the strength of field which reduces the torque. The multiple voltage system, however, has some serious disadvantages. It cannot usually be operated from an outside source of power without rotary transformers; the generating sets and switchboard are complicated, and the total cost of installation is expensive; yet with these draw-backs the system is growing in favor, as it has manifest advantages which outweigh the objections. Storage battery power has been used to some extent to obtain multiple control and is suggestive of interesting possibilities, but in its present form it is not altogether desirable for this purpose. In many of the larger sizes of certain metal-cutting machines it is probable that marked changes will be produced in the immediate future, and the indications are that direct-connected motors with wide variations of speed and power will be incorporated in the new designs.

The recent improvements in the manufacture of certain grades of tool steel have shown indisputably that the present designs of machine tools are not sufficiently heavy to stand up to the work in order to obtain the economy of operation which results from the use of such steels. Higher speeds, heavier cuts and greater feeds may be obtained if the machines will stand the strain, but in most cases the capacity of the machine is not commensurate with the ability of the tool to remove metal. With cutting speeds of 100 to 200 feet per minute, it is evident that the power requirements will be much greater than for the ordinary machines of to-day, which have a cutting speed of from 10 to 30 feet per minute. Here then is an interesting field for the direct-connected motor with ample power and speed variation for any work which it may be called upon to perform.

Compressed Air.— Reference has been made to the use of compressed air power, and its facility of adaptation to various requirements, but it is evident from an inspection of some of the devices in use that enthusiasm for new methods, rather than good judgment, has controlled in many of its applications. For some years compressed air was used only in mines, where it produced marked economies in underground work. Later, compressed air was introduced into manufacturing lines, and to-day its use in railroad and other machine shops, boiler shops, foundries, and bridge works is being widely extended. In the Santa Fé railroad shops at Topeka there are over five miles of pipe in which compressed air is carried to the different machines and labor-saving appliances throughout the works. In such shops air is used to operate riveting machines, punches, stay-bolt breakers, stay-bolt cutters, rotary tapping and drilling machines, flue rollers, rotary grinders, rotary saw for sawing car roofs, pneumatic hammers, chisels and caulking tools, flue welders, boring and valve-facing machines, rail saws, machine for revolving driving-wheels for setting valves, pneumatic painting and whitewashing machines, dusters for car seats and the operation of switching engines about the yard. It is also used in the foundry for pressing and ramming molds, and for cleaning castings by the sand blast; but its greatest field of usefulness is its application to hoisting and lifting operations in and about the works. New applications of compressed air are constantly being made, and each new use suggests another. This has a tendency to increase the number of appliances which are intended to be labor-saving devices, but in many cases the work could be done just as well and much more cheaply by hand. The success and economy which has attended the use of compressed air in so many lines of work has led to its adoption in fields which are much better covered by electrically operated machines. While compressed air has been used under certain conditions very satisfactorily to operate pumps and engines, printing-presses, individual motors for lathes, planers, slotters, dynamos, and other work, it does not follow that it is always an economical agent under these various uses, or that other methods could not be used even more satisfactorily in the majority of cases. It has been proposed to use individual air motors in machine shops and do away with all line shafting, except possibly for some of the heavier machinery. This use of compressed air seems entirely outside the pale of its legitimate field; the general experience thus far indicates that rotary motors are not at all economical and generally are not as satisfactory as electric motors. Exceptions are to be found in the small portable motors for drilling and similar operations, to which electricity is not at all adapted and where compressed air has been found to give excellent results. Although these tools are very successful, they are still rotary motors, not exempt from some of the objectionable features which seem to be inseparable from them. It is not surprising, therefore, to find a tendency to employ reciprocating pistons and cranks in these portable machines, and such tools are now in use weighing only 40 pounds capable of drilling up to two and a half inches diameter. In most cases no attempt has been made to use compressed air power efficiently; its great convenience and the economy produced by its displacement of hand labor have, until recently, been accepted as sufficient, and greater economies have not been sought.

In the matter of compression, very inefficient pumps are still in use, but manufacturers generally have found that it pays to use high-grade economical compressors. The greatest loss is that in the air motor itself. In a large number of cases it is impracticable or, at most, inconvenient to employ reheaters, and the air is used very generally at normal temperature for the various purposes to which it is applied. To obtain the most satisfactory results, the air must be used expansively, but usually where the demand for power is intermittent no attempt has been made to reheat the air, and as a result the combined efficiency of compressor and motor is quite low, varying in general from 20 to 50 per cent. While low working pressures are more efficient than high, the use of such pressures would demand larger and heavier motors and other apparatus which is undesirable.

The advantages of higher pressures in reducing cost of transmission are also well recognized, and the present tendency is to use air at 100 to 150 pounds instead of the 60 or 70 pounds of a few years ago. By reheating the air to a temperature of about 300° F., which may often be accomplished at small expense, the efficiency is greatly increased; in some cases this has been shown to be as high as 80 per cent. While the lower pressures are yet more efficient, the loss due to higher compression is not serious. If the compressed air be used without expansion, it will be seen that there is a material loss in efficiency; but, on the other hand, if it be used expansively without reheating, trouble may be experienced, due to the drop in temperature below the freezing point. If moisture be present, this will cause the formation of ice, which may clog the passages if proper precautions are not taken to prevent it. The low temperature will not in itself cause trouble; if, therefore, the moisture which the compressed air holds in suspension be allowed to settle in a receiving tank, placed near the motor or other air apparatus and frequently drained, less trouble will be experienced from this cause. The greater adaptability of compressed air to various purposes causes its use to increase along with that of the electric motor, for it has a different field of usefulness, independent of power transmission; at the same time, when the requirements are properly observed in its production and use, its economy as a motive power in special cases compares favorably with other systems. But compressed air possesses so many advantages that, however inefficient it may be as a motive power, its application to shop processes will be continually extended as its usefulness becomes better known. See Pneumatic Tools.

Hydraulic Power.— Mention has been made of the use of hydraulic motors as a factor in the subdivision of power, but these are being used to such a limited extent for this purpose that they will not be considered here. There is, however, a growing field of usefulness for hydraulic power in manufacturing operations which is peculiar to this agent alone, namely, its use in forging and similar work. Where hydraulic power exists for this purpose it is also generally used for a variety of purposes which could be accomplished just as well, and often more economically, by steam or compressed air; but in forging operations where heavy pressures are required hydraulic power is infinitely better than either. The compressibility of air is an objection in many lines of work, and it is now well recognized that the effect of a hammer blow is oftentimes merely local. As H. F. J. Porter has so ably shown, the pressure applied in forging a body of iron or steel should be sufficient in amount and of such a character as to penetrate to the centre and cause flowing throughout the mass; as this flowing of the metal requires a certain amount of time, the pressure should be maintained for a corresponding period. Hydraulic pressure, instead of a hammer, should, therefore, be used to work it into shape. Under its action the forging is slowly acted upon and the pressure is distributed evenly throughout the mass, whereas under the high velocity of impact of the hammer the metal does not have time to flow, and thus internal strains are set up in the mass, which may cause serious results, especially with certain steels which have not the property of welding. The quality of the steel is very much improved by the processes of hydraulic forging, and we find a marked tendency to substitute this method in a wide variety of work in which presses are employed varying in capacity from 20 tons to 14,000 tons. It is an interesting fact that the magnificent 125-ton hammer made by the Bethlehem Steel Company now lies idle, while the work for which it was intended is done by a 14,000-ton hydraulic press operated by an engine of 15,000 horsepower. In these works all forgings, except small pieces, are done on hydraulic presses, the largest hammer in actual operation being only of six tons capacity. The pressure used is 7,000 pounds per square inch, but the present tendency indicates the use of a so-called low-pressure transmission service under a pressure of 400 or 500 pounds, with an intensifier at the press which raises the pressure to 2,500, 5,000, 7,000 pounds, or whatever may be required. In this case the lifting and lowering of the ram of the press is effected by low-pressure water, so that the cylinder always remains filled, and the high-pressure is only brought to bear the moment the dies come in contact with the pieces to be forged. The intensifier is built in multiple, which permits of a variable force to suit the work to be done; its action and control are extremely simple, and results are produced which show a marked increase in speed, and a decided economy in operation. Some of the recent German hydraulic forging machines equipped with intensifier operate at a speed of 40 to 70 strokes per minute on finishing, and 20 to 30 strokes per minute for the heaviest work. The success which has attended the use of hydraulic power in forging is causing it to be applied to other and similar work to an increasing extent. In boiler works, railroad and locomotive shops, bridge works, and shipyards it is used along with compressed air, but where heavy pressures are desired hydraulic power is greatly to be preferred; hence we find it operating machines for punching and shearing heavy plates and sectional beams, riveting machines, stationary and portable, flanging and bending machines, tube upsetting machines, wheel and crank-pin presses, lifting jacks, and hoists of all kinds. For heavy boiler work hydraulic riveting seems especially well adapted, as an intensity of pressure can be brought to bear upon the plates which is obtained by no other method.

Transmission.— In the transmission of power by compressed air, within reasonable limits, the loss in transmission if the pipes be tight need not be considered, for although there is a slight loss in pressure due to the frictional resistances of the pipes, yet there is a corresponding increase in volume due to drop in pressure, so that the loss is practically inappreciable. It has already been stated that compressed air as now used without reheating is not at all efficient as a source of motive power, since the combined efficiency of compressor and motor, even under favorable conditions, is not more than 50 per cent of the available energy put into the compressor. In other cases the efficiency is as low as 20 per cent. There should be no comparison between the cost of power by compressed air and its brilliant rival, electricity, since each has its own field of usefulness. With a three-wire 220-volt system, which is very suitable for ordinary shop transmission when both light and power are to be taken off the same circuit, the combined efficiency of generators and motors working intermittently with fluctuating loads will be about 60 per cent of the power delivered to the engine. For greater distances than those which obtain in plants of this character the loss in transmission will be greater, and higher voltage must be employed in order to keep down the line loss. While it is possible to put in conductors sufficiently large to carry the current with any assumed loss, yet the cost of the line becomes prohibitive with low voltage. Where cheap fuel is available it is found in most cases that electric power can be generated at the works more cheaply than it can be purchased from a central station; especially is this the case if the exhaust steam be used for heating purposes. In isolated plants the cost of transmission is very small as compared with the total cost of generation; whereas in the average central station the cost of transmisison, which includes interest and depreciation on pole line, may constitute a large percentage of the operating cost. In those localities where the cost of fuel is high, electric power can often be purchased more cheaply from a central station which obtains its power many miles distant and transmits it electrically to a convenient distributing centre, where it is used for power and light. The recent development in electrical transmission is very marked, and one constantly hears of some new achievement more wonderful than anything previously accomplished. Distances have been gradually increased until it is now possible to transmit electrical energy economically and in commercial quantities up to 150 and even 200 miles. There has been a steadily increasing tendency to raise the line voltage in such transmissions, and to-day we find in successful operation voltages as high as 40,000 and even 60,000 as compared with the 4,000 and 6,000 volts of a few years ago. The possibility of electrical transmission thus permits of the utilization of available sources of power at great distances from the centre of distribution; but while it is interesting to know that a certain amount of power may be transmitted a given distance with a high degree of efficiency, it is more important to know whether the same amount of power could be obtained at the objective point more economically by other means.

Petroleum Fuel.— It has been suggested that the future of long-distance transmission depends largely upon the development of oil as a fuel; but at the present time the outlook for oil fuel in general competition with coal or long-distance transmission is not encouraging. While the development of the Texas and Southern California oil fields has increased the visible supply and brought about increased activity in the use of liquid fuel, yet it is doubtful whether the advantages would be sufficient to cause it to come into general use as a fuel, since with a limited production and an increased demand for this and other purposes the cost would be correspondingly increased.

A number of railroads contiguous to the oil-producing centres have equipped their locomotives to burn this fuel, and it is used to some extent to fire marine boilers, and with great satisfaction,—since its displacement for a given heating value is only about one half that of coal, and the labor cost is materially reduced. It is also used quite extensively in certain sections of the country as a steam producer in power plants, but it is hardly possible that liquid fuel will be a serious competitor of coal. At present, as far as power for manufacturing plants is concerned, it is largely a question of transportation, whether oil can be laid down and handled at a given point more cheaply than coal. It is probable, however, that oil fuel will supply a local demand in certain sections where transportation charges, and possibly insurance, will permit its use at a low cost, and it is in this connection that it may become a competitor of electrical transmission.

Gas-engines.— One interesting phase of the power problem which forcibly presents itself at the present time is the vast possibilities possessed by the modern combustion engine, which includes the various types of gas- and oil-engines. While its use as a motor in industrial establishments has been somewhat limited, yet there is a marked tendency to employ the gas-engine in manufacturing works, and consideration of its advantages and cost of operation, together with its high thermal efficiency and possibility of still further improvement, indicates that, for a great many purposes, both steam-engines and electric motors may be ultimately replaced by gas-engines. That the gas-engine in both large and small sizes has reached a point in its development where it can fairly rival the steam-engine in reliability and satisfactory running qualities, there can be no question. In point of fuel economy, a gas-engine of moderate size is on a parity with the largest triple-expansion steam-engines, and will give a horse-power on less than one pound of fuel. The high price of gas in this country has contributed largely to those causes which have prevented a more common use of the gas-engine as a motor. For this reason the gas-engine has generally been used, not so much because of its high efficiency as a thermo-dynamic machine, but rather on account of its convenience and saving in labor. It is true that natural gas is cheap, but it is equally true that natural gas is not generally available. Fortunately the manufacture of producer gas has reached a high state of development, and there are now in successful use several processes by which power gas can be made from cheap bituminous coals as well as anthracite and coke. The leanness of such gases renders them less effective per cubic foot of gas, as compared with the richer coal gas or even water gas; but this difference is more than compensated for by the low cost of production. It is upon such power gas that the commercial future of the gas-engine as a general motor depends.

A prominent factor in gas-engine practice which has attained a high degree of development in European practice is the small gas-producer. These generators are very simple in operation, and furnish a convenient and economical means of obtaining power at a much lower rate than with the ordinary city lighting gas. The economy of these small producers is shown by tests which give one horse-power on a 16 horse-power engine with a consumption of only 1.1 pound of fuel. For engines above 40 horse-power one horse-power can be obtained on seven eighths pound of fuel. The successful employment of large combustion engines with blast furnace gases as the explosive medium, utilizes vast sources of power which a few years ago were allowed to go to waste or, at most, were used very inefficiently. The high thermal efficiency of the gas-engine has long been recognized and the possibility of further development is a promising factor in this field. The already accomplished efficiency of 38 per cent reported by Professor Meyer, of Göttingen, greatly exceeds the maximum theoretical efficiency of the steam-engine and more than doubles its actual best obtainable working efficiency. With higher compression even greater efficiencies may be expected. But with high compression there is danger of premature explosion, due to the generation of heat in compressing the gas in the presence of oxygen; for this reason Herr Diesel compresses the air separately. Under a pressure of 500 pounds or more, which is used in the Diesel motors, the air becomes very hot and readily ignites a charge of liquid fuel which is injected into the compression chamber. There is no explosion; combustion occurs while expansion goes on, and the heat generated disappears in the form of work. In England, during the year 1901, there were in use, or under construction, 327 gas-engines capable of supplying 182,000 horse-power. This gives an average of about 560 horse-power per engine. As compared with this, the last United States Census Report states that, during the census year 1899, there were constructed in the United States 18,500 combustion engines having a total capacity of 165,000 horse-power, or only about 9 horse-power per engine. Although this country has lagged somewhat behind Europe in adopting large gas-engines, there is evidence that this state of affairs will not exist very long, for a number of firms are now in the field building gas-engines from 1,000 to 4,000 horse-power capacity. The use to which these large engines are put is about equally divided between the operation of blowing engines for blast furnaces and the driving of dynamos for general power distribution. While the gas-engine in the larger sizes is thus used extensively for the generation of electric light and power, a growing tendency is observed to use the gas-engines direct as motors. A number of railroad and other machine shops have been equipped with moderate sized gas-engines suitably located about the works, and in addition, thousands of horse-power are used in the smaller sizes for a wide variety of purposes, including village waterworks, isolated lighting stations, and manufacturing plants of all kinds. With the possibilities of high thermal efficiencies we may look with much hope upon the still higher development of cheap fuel gas processes that will bring the gas-engine into very general succession to the electric motor for power purposes, for it will doubtless be found that gas transmitted from a central gas-making plant at a manufacturing works into engines located at points of use will effect a material saving in the utilization of power over any existing methods. It is not to be presumed that the gas-engine will displace either the electric motor or the steam-engine; each has its legitimate sphere of usefulness, and each will be more highly developed as the result of direct competition. Yet the economies already obtained indicate that the field of the gas-engine will be gradually extended into that of the steam-engine and the electric motor.

Steam-turbines.— Many of the questions involved in this consideration are at the present time in a transitional stage. The reciprocating steam-engine has reached a high state of development, but it is not probable that it has attained its highest degree of perfection. While an economy of less than 9½ pounds of steam per horse-power hour has been obtained, even better results may be anticipated; the use of high pressure superheated steam in compound, jacketed engines involves more perfect lubrication, and this may demand modification in existing valve types; however this may be, the outlook is promising for still higher efficiency; whether this will mean cheaper power than can be obtained in other ways will depend upon many conditions. In any case, and especially with intermittent or variable loads, it is not so much a question of maximum efficiency as it is economy of operation.

From this point of view the present activity in the construction and development of the steam-turbine is of interest to engineers and power users. The steam consumption of a modern steam-turbine of moderate size compares very favorably with that of the better class of large reciprocating engines, but what is of greater importance is the evident superior steam economy under variable loads. The steam consumption per horse-power hour varies little from one third to full load; at over-loads the economy, as shown by numerous tests, may be even better. This feature predestines the steam-turbine to the special field of electric lighting and power generation, where it must inevitably become a formidable rival of the larger-sized, slow-speed reciprocating steam-engine. The high rotative speed of the steam-turbine is a prominent factor in favor of its adoption in connection with electrical generators, since the cost of the generator end of the equipment ought eventually to be very materially reduced; but for many lines of work the high rotative speed of the present types of steam-turbine is prohibitive, nor can it be adapted successfully to belt-driving, except by the use of gearing. However, it is fair to presume that the attention now being given to its development will evolve a more universal type of motor adapted to general power purposes with large and small units alike.

The economies already obtained with both the steam-turbine and the gas-engine have brought each into a prominence which is at least suggestive of the important developments that are taking place in methods of obtaining and using power.

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Pow'ers, Hiram, American sculptor: b. Woodstock, Vt., 29 July 1805; d. Florence, Italy, 27 June 1873. He received his education at the district school, and on the removal of the family to Ohio in 1819 was employed as assistant to a clock-maker. He was subsequently appointed director of the waxwork department of the Western Museum of Cincinnati, an employment he pursued for seven years. In 1835 he went to Washington, and was for some time employed in modeling busts of distinguished men. With the proceeds derived from these efforts, and the aid of Gen. Preston, he was enabled to visit Italy. In 1837 he established himself at Florence, where he resided until his death. His statue of 'Eve Tempted,' which excited the approval of Thorwaldsen, was produced in 1838; in 1843 was modeled the still more popular 'Greek Slave,' of which six copies in marble, and innumerable casts and reduced copies, are in existence. Among his other statues the most notable are: 'The Fisher Boy' (1846); another 'Eve Tempted' (1850); 'America' (1854), destroyed by fire in 1866; 'Il Penseroso' (1856); 'California' (1858); and 'The Indian Girl' (1872); and statues of Washington for the State of Louisiana, of Calhoun for South Carolina, of Webster for Boston, and of Franklin and Jefferson. He also executed several ideal busts, such as 'Ginevra' (1840); 'Proserpine' (1845); 'Psyche' (1849); 'Diana' (1852); 'Christ' (1866); 'Faith' (1867); 'Hope' (1869); and 'Charity' (1871); besides busts of Jackson, Adams, Everett, Van Buren, and Longfellow.

Powers, Le Grand, American statistician: b. Preston, N. Y., 1847. He was graduated at Iowa State University in 1872 and was engaged in active ministerial work 1874–90. He was commissioner of labor in Minnesota 1891–9, and has since been chief statistician of the 11th Census, in charge of agriculture. He has published 'Minnesota Bureau of Labor Biennial Reports' (1890–9); 'Farmer Hayseed' (a reply to 'Coin's Financial School'); etc.

Powhatan, pow-ha-tăn', Indian sachem: b. about 1550; d. 1618. This was the name of his tribe; his own was Wahunsonacook. Originally he was at the head of eight tribes, but being a man of great natural abilities, raised himself from the rank of a chieftain to the command of 30 tribes, numbering about 8,000. (See POWHATAN INDIANS.) His dominions included the country between the James and Patuxent, and extended into the interior as far as the falls of the chief rivers. One of his abodes was a village of a few wigwams near the present site of Richmond. A large guard of warriors usually attended him, and his dwelling was watched at night by sentinels. After the extension of his power northward, he dwelt mainly at Werowocomoco, on York River, in the present county of Gloucester, a few miles from Jamestown. He was disposed to look with dislike upon the coming of the whites. Capt. John Smith, in 1607, was held for some time by Powhatan as a prisoner, and according to the tradition, when Smith had been condemned to death, the sachem yielded to the entreaties of his daughter Pocahontas (q.v.) and spared his life. Two years later Powhatan was crowned "Emperor of the Indies" by Smith and Capt. Christopher Newport, during a visit which they paid him in quest of supplies. Smith afterward made an unsuccessful attempt to capture Powhatan in order to obtain a supply of corn, and in revenge for this Powhatan prepared to exterminate the English, but was foiled by the watchfulness of Pocahontas. The quarrels between Powhatan and the English did not cease until the marriage of his daughter to John Rolfe (q.v.), after which he was their firm friend. Smith's description of Powhatan represents him as a «tall, well-proportioned man, with a sour look, his head somewhat gray, his beard so thin that it seemed none at all, his age near sixty, of a very able and hardy body to endure any labor.»

Powhatan Indians, an American confederation of 30 tribes living south of the Potomac River about the time of the settlement of Jamestown. The entire confederation numbered 8,000. There are no known descendants of any of these tribes. The chief was also called Powhatan (q.v.).

Pow'nall, Thomas, English statesman, colonial governor, and author: b. Lincoln 1722; d. Bath 25 Feb. 1805. He was graduated at Cambridge in 1743, 10 years later emigrated to America, became private secretary to Governor Osborn of New York, and in 1757 was made governor of the colony of Massachusetts Bay. Having been recalled at his own request, he succeeded Sir Francis Bernard as lieutenant-governor of New Jersey in 1760. He was also appointed to the governorship of South Carolina; but without going to that colony, in 1761 he returned to England, was made comptroller-general of the expenditures of the army in Germany, and in 1768 elected to Parliament. He earnestly opposed the measures of the government against the colonies. After being three times returned to Parliament, he retired in 1780, and passed the remainder of his life in antiquarian studies. In the sphere of scholarship he achieved a greater reputation than that which he won in the field of politics. His writings have a wide range of subjects, and among his principal works are: 'Administration of the Colonies' (1764); 'A Topographical Description of the Middle Colonies' (1776); 'A Memorial to the Sovereigns of Europe on the State of Affairs between the Old and the New World' (1781); 'A Memorial to the Sovereigns of America' (1873); 'Notices and Descriptions of the Antiquities of the Provincia Romana of Gaul' (1788); 'A Memorial to the Sovereigns of Europe and the Atlantic' (1803); 'Intellectual Physics'; 'Principles of Polity'; and a 'Treatise on Old Age.'

Poynings, poin'ingz, Sir **Edward,** English statesman: b. 1459; d. 1521. He was active in the Kentish revolt against Richard III. in 1483 and two years later came to England in the train of the Earl of Richmond, afterward Henry VII. He went as lord deputy to Ireland in 1494, and while there summoned a Parliament at Drogheda which at his instigation gave to the English crown and Privy Council direct control of Irish administrative affairs. The act passed on this occasion is known as the Poynings Law. (See Ireland, *History.*) He was recalled in 1496 and was subsequently warden of the Cinque Ports.

Poyning's Law, or **Statute of Drogheda,** an act of the Irish parliament, passed in 1495, whereby all general statutes before that time made in England were declared of force in Ireland. It was so named from Sir Edward Poynings, deputy of Ireland under Henry VII.

Poynter, poin'tĕr, Sir **Edward John,** English painter: b. Paris 20 March 1836. He received his early education in Westminster School and in Ipswich, and was the pupil of Gleyre in Paris from 1856 to 1859. In 1860 he returned to London and was elected Royal Academician in 1876. His paintings in oil and water colors are distinguished by originality of conception, faultless drawing, and strong color qualities, and the most remarkable of them are: 'Israel in Egypt' (1867); 'The Catapult,' an incident in the siege of Carthage (1868); 'Faithful unto Death'; 'Proserpine'; 'Perseus and Andromeda' (1872); 'The Fortune Teller' (1877); 'Rhodope'; 'The Golden Age'; 'Zenobia in Captivity' (1878); 'The Visit of the Queen of Sheba to Solomon' (1890). During the years 1872–3 he was engaged in frescoing the walls of Saint Stephen's Church, Dulwich. He also furnished designs for the decoration of the interior of the dome of Saint Paul's Cathedral with subjects from the Apocalypse, as well as for the mosaics in Westminster palace. On the death of Sir John Millais in 1896 he was elected president of the Royal Academy and the same year was knighted. He also published: 'Ten Lectures on Art' (1879).

Poynting, poin'tĭng, **John Henry,** English scientist: b. Monton, Lancashire, 9 Sept. 1852. He was educated at Owens College, Manchester, and Trinity College, Oxford, was assistant to Prof. Balfour Stewart in the physical laboratory at Owens in 1876–9, and in 1880 was appointed to the chair of physics at Mason College (now Birmingham University). He has contributed papers on electrical theory and the mean density of the earth to the 'Philosophical Transactions' and the 'Proceedings' of the Royal Society; published his Adams prize essay on 'The Mean Density of the Earth' (1891); and (with J. Q. Thomson) 'A Text-book of Physics.'

Pozzo di Borgo, pŏt'sō dē bŏr'gō, **Carlo Andrea,** Count, Russian diplomat: b. Alata, Corsica, 8 March 1764; d. Paris 15 Feb. 1842. He became an advocate, and in 1791 was elected to the National Assembly, but withdrew from France for safety, and became president of the council under English rule in Corsica. In 1802 he entered the Russian service as councillor of state, and was employed in various missions of importance. After the Russian treaty with Napoleon, he resigned, and traveled widely until recalled by the Emperor Alexander. He thereupon devoted himself to maintaining an energetic prosecution of the war against France. He concluded the alliance with Sweden, and in 1814 visited England for the purpose of influencing British policy. His services were fully recognized. He attended with the emperor the Congress of Vienna, was ambassador to France in 1830–4, and to Great Britain in 1834–9. Consult Vuhrer, 'Notice Biographique sur le Comte Pozzo di Borgo' (1842).

Pozzuoli, pŏt-soo-ō'lē, Italy, a city on the gulf of the same name, six miles west of Naples, at the western foot of the Solfatara and in a volcanic country known to the Romans as the

Phlegræan Fields. Near by is the Avernian Lake famed as the entrance to Hell both in Virgil's sixth Æneid and in early Christian legend, which pointed out here the place where Christ descended into Hell. Remains of Cicero's villa are near the town, which is particularly famed for its amphitheatre, where 30,000 spectators could sit and in which there were naval battles as well as the ordinary gladiatorial contests. The so-called Serapeum is an archæological puzzle and may have been a town hall; traces of the action of sea water on several pillars not now touched by high water seem to prove that the coast, possibly from volcanic disturbances, has undergone marked and recurrent changes. The only other ruin of importance is that of the temple of Augustus, the site of which is occupied by the cathedral, which preserves six of the original Corinthian columns. Pozzuoli is a good fishing-port; exports the volcanic sands called pozzuolana, which are used in making cement; has important mineral baths in the vicinity; and is the site of an ordnance factory, a branch house of Armstrong & Co., which makes armor plate and cannon for the Italian government.

Pozzuoli was founded by Greek exiles from Samos 528 B.C., as Dicæarchia, but the Italians called it Puteoli, "the wells," because of the sulphurous cavities in the earth, and this name stuck to the Roman colony founded here in 194 B.C. The city became the greatest port of Italy and an entrepôt for Oriental commerce; goods were sent overland hence to Rome and the dangerous navigation of the coast of Latium avoided. Even after Ostium was built the port retained its importance, and its beautiful coast and curative springs and baths made it a famous resort.

Pradier, prä-dē-ä, **James**, French sculptor: b. Geneva 23 May 1792; d. 14 June 1852. He went to Paris in 1809, and studied design under Meynier, and sculpture in the studio of Lemot. In 1813 he gained the prize of the Academy for a bas-relief of Philoctetes and Ulysses, and this work procured his admission to the French Academy at Rome. Here he studied the antique, and returned to Paris with two statues, one of a Bacchante and the other of a son of Niobe. In 1821 he went again to Rome, where he remained till 1823, and brought back a beautiful statue of Psyche, which he had made out of part of the shaft of an ancient marble pillar found at Veii. From this period he worked constantly at Paris, and produced a great number of larger and minor sculptures, including a Venus, a most lovely group of the Three Graces, a plaster statue of Jean Jacques Rousseau, after which the casting at Geneva has been made, and Cyparissus with his goat and a huntress. Admitted to the Institute in 1827, he afterward executed, among other works, a Prometheus, a Faun and Bacchante, a Phidias, the bas-reliefs on the pediment of the chamber of deputies, the allegorical figures of Lille and Strasburg in the Place de la Concorde at Paris, the Industry in front of the exchange, the Flora, which he considered one of his most successful works, the twelve colossal Victories on the monument of Napoleon in the Hotel des Invalides, the Atalanta in the exhibition of 1851, and the Sappho exhibited in 1852. The execution of his works ranks him a sculptor of the first order, but he is deficient in originality of conception, his monotone borders on insipidity, and he sometimes strives to give life to his creations by a touch of meretriciousness.

Pradilla, Francisco, frän-thēs'kō prä-dēl-yä, Spanish painter: b. Villanueva de Gallego, in the province of Saragossa. His initiation into art came through his employment as a decorator of theatres, but in 1863 he arrived at Madrid where he devoted himself to the study of the old masters, became a pupil of Serri and completed his artistic education in the Spanish Academy of Fine Arts at Rome. His first signal achievement in art was 'The Rape of the Sabines'; followed in 1878 by 'Joanna the Mad, following the Coffin of Philip the Fair, her Husband'; this was awarded a medal at the World's Exposition at Paris the same year. His next important work was 'The Surrender of Granada to Ferdinand and Isabella,' a picture remarkable for spirited delineation of character, life-like action and grandeur of style. At the Exposition in Munich (1883) it was awarded first medal. In addition to these larger works he has produced numerous small genre pictures, illustrating modern life, and indicating keen observation, and subtle power of individualization. Among these is 'Market Day at Vigo'; 'High Mass in the Pilgrims' Chapel at Guia,' and 'Pilgrimage to the Shrine of Our Lady of Good Counsel.' These small canvases are masterpieces of their kind and have won for him a European reputation.

Prado, prä'thō, **Mariano Ignacio**, Peruvian politician: b. Huanaco 1826. He engaged actively in a revolution which in 1854 overthrew General Echenique and led the opposition to President Pezet in 1865 which resulted in Pezet's resignation and his own election to the presidency. He then formed an offensive and defensive alliance against Chile, and declared war with Spain. A Spanish attack upon Callao was repulsed 2 May 1866, but his own position having been declared unconstitutional, he was obliged to leave Peru in January 1868. Returning several years later he was elected president in 1876 and in 1879 declared war against Chile. Prado went to Europe in the same year, for the purpose, as was then stated, of obtaining a loan and ironclads, and in his absence the presidency was seized by Pierola. He returned to Lima in 1886, but ceased to be active in politics.

Pradt, Dominique Defour de, dō-mē-nēk dü-foor dė prät, French prelate: b. Allanches, Auvergne, France, 1759; d. Paris, France, 1837. He entered the priesthood, and at the outbreak of the French Revolution was grand-vicar to the archbishop of Rouen. He represented the clergy of Normandy at the constituent assembly where he supported the clerical and royalist parties, and after the Convention fled to Hamburg. He returned to France in 1799, gained the favor of Napoleon, became his first almoner in 1804 and later bishop of Poitiers. In 1808 he was made archbishop of Mechlin and an officer of the Legion of Honor, but in 1812, when sent as ambassador to Warsaw failed in his mission, thereby incurring the displeasure of Napoleon, who removed him from his office as almoner and ordered him to his diocese. He later sold his right to the archbishopric to the king of the Netherlands. Deprived of his office of chancellor he became simply the Abbé de Pradt and engaged in bitter attacks on the banished Napoleon, and after vain attempts to gain influence with the Bourbons began to write in favor of constitutional freedom and against the abuses of the clergy. Among his works are: 'Antidote au Congrès de Rastadt' (1798); 'Historie de l'Ambassade dans le Grand Duché de Varsovie' (1815); 'Des Colonies et de la Révolution actuelle de l'Amérique' (1817); 'L'Europe et les Colonies depuis le Congrès d'Aix-la-Chapelle' (1821); etc. Consult De Lastic-Rochegonde, 'Dominique de Pradt' (1897).

Praed, prād, **Mrs. Campbell.** See Praed, Rosa Caroline Murray-Prior.

Praed, Rose Caroline Murray-Prior, English novelist: b. Bromelton, Queensland, 27 March 1852. In 1872 she was married to Campbell Mackworth Praed (d. 1901) and in 1876 went to London where her Australian stories soon made her well known. Among her many popular fictions are: 'An Australian Heroine' (1880); 'Moloch' (1883); 'The Head Station' (1885); 'December Roses' (1892); 'Outlaw and Lawmaker' (1893); 'Nulma' (1897). She published 'My Australian Girlhood,' an autobiography, in 1902, and with Justin McCarthy (q.v.) has written 'The Right Honorable' (1886); and 'The Ladies' Gallery' (1889), novels of political and social life.

Praed, Winthrop Mackworth, English poet: b. London 26 July 1802; d. there 15 July 1839. He was educated at Trinity College, Cambridge, was elected to a Trinity fellowship in 1827, and in 1829 was admitted to the bar. In Parliament he sat for Saint Germans in 1830–2, for Great Yarmouth in 1834–7, and for Aylesbury from 1837. Praed made some successful speeches in the House, and was requested by Wellington to write for the *Morning Post,* a defense against certain attacks on the Duke in the *Times.* His political writing was too restrained wholly to reach its mark; but his verse is marked by a lightness of touch and a metrical ease and finish which in more recent times finds its closest resemblance in the work of Austin Dobson. He excelled in *vers de société,* though he displayed, as in the 'Red Fisherman,' an imaginative force which suggests broader fields. The best edition of Praed's poetical works is the authorized one of 1864.

Præ'fect, the title of various functionaries of ancient Rome. Of these the most important was the *præfectus urbi* or *urbis,* or warden of the city, originally called *custos urbis.* The name *præfectus urbi* does not seem to have been used till after the time of the decemvirs. During the kingly period and the early years of the republic the *custos urbis* exercised within the city all the powers of the chief of the state in his absence; he convoked the senate, held the comitia, and on any emergency might take such measures as he thought proper. When the office of *prætor urbanus* (see Prætor) was instituted the wardenship of the city was merged in it; but the conservative spirit of the Romans still induced them to appoint annually a *præfectus urbi* for the time during which the consuls were absent from the city to celebrate the Feriæ Latinæ, a festival held on the Alban Mount. Under Augustus, however, the office ceased to be a sinecure. The *præfectus urbi* was a permanent magistrate whom the emperor invested with all the powers necessary to maintain peace and order in the city. He had under him a sort of police called *milites stationarii;* and the powers of the office were gradually so far extended that at last there was no appeal from his sentence except to the emperor. The *præfectus prætorio* was the officer who commanded the troops who guarded the emperor's person. (See Prætorian Guards.) The office was first instituted by Augustus, and was at first only military, and had comparatively little influence attached to it; but under Tiberius it became second only to that of the emperors. From the time of Severus to that of Diocletian the præfects had the superintendence of all the departments of the state — the palace, the army, the finances, and the law; they also had a court in which they decided cases. In addition to these functionaries there were the *præfectus aquarum,* charged with the regulation of the water supply of the city; the *præfectus ærarii,* who had charge of the public treasury; the *præfectus vigilum,* who commanded the night-watch; with others of less importance.

Præmunire, prē-mū-nī'rē, the opening words of the writ issued preparatory to the prosecution of certain offenses supposed to imply legal contempt toward the sovereign or the government — *præmonere* or *præmunire facias* A. B. (Cause A. B. to be forewarned that he appear before us, etc.) The first statute of præmunire was passed during the reign of Edward I., and was intended to repress the papal encroachments on the rights of the crown, and several subsequent statutes before the Reformation greatly extended the number of penal acts under this title, and by still later statutes acts of a very miscellaneous nature have been rendered liable to the penalties of præmunire, as knowingly and wilfully solemnizing, assisting, or being present at any marriage forbidden by the Royal Marriage Act; asserting by preaching, teaching, or advisedly speaking that any person other than according to the acts of settlement and union has any right to the throne, or that the sovereign and Parliament cannot make laws to limit the descent of the crown; to assert that both or either of the Houses of Parliament have or has a legislative authority without the sovereign; and so on. Cathedral chapters in England which refuse to elect the bishop nominated by the Crown are liable to be prosecuted on præmunire. The punishment is forfeiture and imprisonment during the sovereign's pleasure.

Præneste, prē-nĕs'tē. See Palestrina.

Præ'tor, originally the official title of the consuls at Rome. When the patricians were compelled to acquiesce in the consulship being thrown open to the plebeians, they stipulated that a new curule magistrate should be appointed from the patricians exclusively, to act as supreme judge in the civil courts. On this magistrate the title of prætor was bestowed. In 337 B.C. the prætorship was thrown open to the plebeians. About 240 B.C., the number of aliens residing in Rome had increased to such an extent that it was found necessary to appoint a second prætor, who should decide suits between aliens or between aliens and citizens. He was known as the *prætor peregrinus,* the other prætor, *prætor urbanus,* having cognizance of suits between citizens only. In 227 B.C., the number was increased to four, the two additional prætors to act as governors of provinces. By Sulla the number was augmented to eight, by Julius Cæsar to 10, 12, and eventually to 16. The prætors held their offices for one year, and were afterward sent out by lot as governors of provinces.

Prætorian Guards, a body of permanent troops, established by Augustus as Imperial Life Guards, in imitation of the *cohors prætoria*, or bodyguard attached to the person of the commander-in-chief of a Roman army. The Prætorian guards were kept up by successive emperors, and, being under special organization and enjoying several privileges, they became in time so powerful that they were able to raise and depose emperors at their will. They were reorganized by Septimius Severus, and were finally suppressed by Constantine the Great.

Præto'rium, (1) the official residence of a prætor or governor of a Roman province: hence, a hall of justice; a judgment-hall; a palace. (2) That part of a Roman camp in which the general's quarters were.

Praga, prä'gä, Russian Poland. See WARSAW.

Pragmat'ic Sanction (*Sanctio Pragmatica*), a public edict relating to important state business, pronounced by the head of the legislature, and differing from the simple rescript, in that the latter was a declaration of law in answer to a question propounded on behalf of an individual. The pragmatic decree was considered irreversible. In European history the following are the most important pragmatic sanctions. (1) That ascribed to Louis IX. of France, but not brought to light till 1468 and in reality an expansion of that of Charles VII. (2) The ordinance of Charles VII. of France, drawn up at Bourges in 1438, conformably to the decrees of the Council of Basel, and on which rest the claims of the Gallican liberties. It was repealed by Francis I. (3) The decree of the German Diet at Mainz in 1439 which sanctioned the Basel decree. The two last limited the papal power, but were altered by subsequent concordats. (4) The instrument by which the German emperor, Charles VI., being without male issue, endeavored to secure the succession to his female descendants. It was in accordance with this instrument that he settled his dominions on his daughter Maria Theresa. He induced most of the European sovereigns to guarantee it; but Charles Albert, elector of Bavaria, the next heir to his dominions, refused; this caused the Austrian war of Succession after the death of the emperor in 1740. In the Peace of Füssen (1745) Bavaria acknowledged the pragmatic sanction. (5) Charles III. of Spain, when he ceded the throne of Naples to his third son and his successors in 1759, called the law of succession which he prepared for this branch of his family *sanctio pragmatica*.

Pragmatism. The term pragmatism, as employed in philosophy at the present time, denotes the general tendency to subordinate logical thinking to the ends of practical life, and to find the test of the truth of ideas in their practical consequences. There are thus two somewhat distinct sides to the doctrine, which we find differently emphasized by different writers. On the one hand, this view points out that thought owes its origin to the needs and demands of the practical life. Thought is thus a tool or instrument that is always invoked to meet a particular crisis or problem resulting from a concrete situation. Thought, therefore, does not aim at truth in general. Its business is to discover, in concrete circumstances, the best means to the realization of some practical end that life demands.

This side of the doctrine has been chiefly elaborated by Professor John Dewey and those associated with him at the University of Chicago as colleagues or students. These writers have connected their theory with the doctrine of evolution, and support it mainly by arguments and analogies drawn from this source. On the other hand, to decide regarding the truth or falsity of any theory or conception, we must also appeal to the practical consequences that result from it. A theory is demonstrated in the only possible way when it is shown that it will «work»; that is, that the results that we wish to obtain in a given situation follow from it. It is only in the light of these results that a conception has meaning. Apart from its practical consequences, a conception is an abstraction without meaning or significance, and consequently without truth or falsehood.

This practical test of the truth of a theory through an appeal to its consequences, is the element in pragmatism that has been mainly emphasized by C. S. Peirce and Professor William James. Peirce first employed the term and outlined the theory in an article in 'The Popular Science Monthly' (January 1878); but the present currency of the position in America and England is largely due to Professor James, who has elaborated and enforced it in his psychology and in a number of popular works and articles. The names of Peirce and James are so closely connected with pragmatism that we quote here the formal definitions of the term which they have written for Baldwin's 'Dictionary of Philosophy.' Peirce describes the doctrine as follows: «The opinion that metaphysics is to be largely cleared up by the application of the following maxim for attaining clearness of apprehension: 'Consider what effects, that might conceivably have practical bearings, we conceive the object of our conception to have. Then our conception of these effects is the whole of our conception of the object.'» James defines pragmatism: «The doctrine that the whole 'meaning' of a conception expresses itself in practical consequences, consequences either in the shape of conduct to be recommended, or in that of experience to be expected, if the conception be true; which consequences would be different if it were untrue, and must be different from the consequences by which the meaning of other conceptions is expressed. If a second conception should not appear to have other consequences, then it must really be only the first conception under a different name. In methodology it is certain that to trace and compare their respective consequences is an admirable way of establishing the differing meanings of different conceptions.»

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Prague, prāg, Austria-Hungary, the capital of Bohemia, and the third largest city of the empire, 217 miles by rail northwest of Vienna, and 118 miles southeast of Dresden. Its site is a regular basin, traversed by the river Moldau, from the banks of which the city's buildings rise in terraces, till they are terminated and enclosed by hills of considerable height. Of nine bridges including two railway viaducts the most striking is the Karlsbrücke, dating from 1357–1503, and reconstructed after damage by a flood in 1892; it is 543 yards long with tower gateways at each end, and the buttresses adorned with statues of John of Nepomuk and other saints. The mediæval fortifications and ramparts have been gradually demolished since 1866, and their sites occupied by pleasure grounds, boulevards, dwellings, etc. Among the chief quarters of the town are the Altstadt, Josephstadt, and Neustadt on the right, and the Kleinseite and Hradschin on the left bank. Outside the line of the old walls lie the suburbs Karolinenthal, Smichow, Wyschehrad, Bubna, and others. The Altstadt and Josephstadt lie along the right bank toward the north. The streets of the Altstadt are narrow; it is the principal seat of trade and business, and contains some of the best stores, besides numerous churches, ecclesiastical and educational establishments. The Neustadt encloses the Altstadt on the northeast, east, and southeast. Though newer than the other, it is still very ancient, having been built by the Emperor Charles IV. in 1348. On the opposite side the Kleinseite forms the aristocratic quarter, the chosen abode of the Bohemian nobles, and the site of several remarkable palaces. The Hradschin, to the west and south of the Kleinseite, occupies the side of a steep hill, is of less extent, and contains fewer houses than the other quarters, but the chief public edifices. Among these are the old castle, or palace of the Bohemian kings, situated in the Hradschin; the Gothic cathedral, also in the Hradschin; the Clementinum, the seat of the theological and philosophical faculties of the university and the Carolinum, devoted to the faculties of law and medicine; the Teynkirche, a Gothic church, historically interesting as the place where the Bohemian estates made George Podiebrad their king, and containing the grave of the celebrated astronomer Tycho Brahe, who spent his last years at Prague; the palace of Wallenstein, originally a structure of great magnificence, but now much dilapidated; the Alte Rathaus (old townhall), an irregular Gothic edifice of the 15th century, with a dungeon beneath in which the Emperor Wenceslas IV. was confined for 15 weeks; the chief synagogue of the Jews, probably as ancient in date as the end of the 12th century; the military hospital, a large and magnificent edifice, originally erected by the Jesuits as a college; the theatre, the opera house, the national museum, museum of natural history, picture gallery, the technical high schools, Landesbank (1896), municipal savings bank (1894), central market hall (1896), the new Ritterakademie (1896), etc. The university, founded in 1348, had 10,000 students at the beginning of the 15th century; but subsequently it had a long period of inactivity. It received a new constitution in 1881, having now two co-ordinate sides or sections, one German and one Czech, with respectively 156 and 140 teachers, and 1,470 and 2,361 students. It possesses a library of 195,000 volumes and 3,800 manuscripts, a fine observatory, museums of zoology and anatomy, a botanical garden, etc. The manufactures consist of gold and silver embroidery, silk, woolen, cotton, and linen goods, buttons, hats, leather, paper, soap, refined sugar, vinegar, liqueurs, refined salt, gloves, sugar of lead, stearine and tallow candles, machines, musical and mathematical instruments, firearms, porcelain, jewelry, etc. The trade is of great importance; Prague, owing to its central position, and to its facilities of transport by river, roads and railway, being the great entrepôt for all the traffic of the kingdom. It has also several important fairs, particularly one for wool, which lasts seven days, and during which a great amount of business is done; that of St. Wenceslas, the old patron saint of Bohemia; and that of St. John Nepomuk, though these two are rather religious festivals than fairs, and are more crowded with devotees than dealers.

Prague is supposed to have been founded in 722 by the Duchess Libussa. In 1348 Charles IV. founded the university, the first which Germany possessed, and it soon acquired such celebrity through the teachings of such zealous rectors as Huss and Jerome that it was resorted to from all quarters of Europe. In 1424 Prague was taken by the Hussites and almost destroyed, but after their submission to the emperor in 1433 the town was rebuilt. It suffered severely in the Thirty Years' war, and in 1620 a battle was fought at the White Mountain in the neighborhood, in which the Elector-palatine Frederick V. was defeated by the Emperor Ferdinand II., and compelled to renounce his crown. In 1631 the city was captured by the Saxons, who were driven out a few months later by Wallenstein. In 1742 it was taken by the French and Bavarians, and two years later capitulated to Frederick the Great. After the Seven Years' war the city made rapid strides, and enjoyed peace and prosperity until 1848, when the Austrian government caused it to be bombarded for two days, owing to the marked democratic demonstrations excited by the meetings of the Slavonic Congress within its walls. During the Austro-Prussian war in 1866 the city was occupied by the Prussians, and here the treaty of peace was signed on the 23d August. Pop. about 210,000, the majority Czechs.

Prahran, prä-răn', Australia, a town in the state of Victoria, four miles southeast of and suburban to Melbourne (q.v.). It is a separate municipality and in 1879 was made a city. Pop. about 42,000.

Prairie, a treeless region in the Mississippi Valley, adjacent to the forested area, so called since the time of the early French explorers. The eastern border of the prairie region is an irregular line crossing Minnesota and Wisconsin in a southeasterly direction, and extending into western Indiana, thence crossing Illinois and Missouri southwesterly to the Indian Territory and eastern Texas. From this forest line the prairies extend westward from 200 to 600 miles to the Great Plains, into which they merge quite imperceptibly. In general we may say that the characteristics of the prairies are intermediate between those of the adjacent forests on the east and the plains on the west. The soil, climate, rainfall, etc., of the prairies are much like those of the western edge of the forests. As we go westward the soil becomes more sandy, the climate more "continental" and the rainfall less, approaching the conditions which prevail on the plains.

The soil of the prairies is usually dark in color and rich in organic matter. It is composed of very fine particles, and when dried after wetting becomes very hard. It contains much finely divided sand, and is generally somewhat deficient in clay. While very rich and often of great depth, it is by no means inexhaustible, and the better classes of farmers have found it profitable to add fertilizers from time to time.

The climate of the prairies is somewhat more severe than that of the adjacent forest areas, on account of the free sweep of the winds which intensify the cold of winter as well as the heat of summer. The annual rainfall is about thirty inches, diminishing somewhat as we go westward, and this is so distributed that by far the greater portion falls in the spring and summer.

Although the prairies are usually spoken of as treeless, this is not strictly true, since the streams are always fringed with trees, the treeless areas extending over the higher lands from stream to stream. Yet since these forest fringes are often confined to the deep narrow valleys in which the streams flow, they are often scarcely noticeable as one looks over the landscape. The vegetation of the prairies naturally divides itself into that of the open country, and that of the woodlands. In the open country the grasses constitute the dominant vegetation, since they are mostly perennial, and very tenacious of life. The species which are most common are grama (*Bouteloua oligostachya, B. curtipendula, B. hirsuta*), buffalo grass (*Bulbilis dactyloides*), drop-seed grass (*Sporobolus,* of several species), wild June grass (*Koeleria cristata*), blue-stem (*Andropogon,* of several species), switch grass (*Panicum virgatum*), beard-grass (*Aristida,* of several species), Muhlenberg grass (*Muhlenbergia,* of several species), sand-grass (*Calamagrostis*), porcupine-grass (*Stipa spartea*), Eaton grass (*Eatonia*), spear-grasses (*Poa*), fescue grasses (*Festuca*), brome-grasses (*Bromus*), wheat-grasses (*Agropyrum*), and wild-rye (*Elymus*), each of many species. Altogether about 150 native species of grasses grow upon the prairies, affording fine pasturage and hay for stock. In those portions of the prairies where the rainfall is abundant these grasses constitute a continuous sod which completely covers the surface, but where there is less rain they are in isolated clumps or bunches, and are then called "bunch grasses." In all prairies there are other plants which grow intermingled with the grasses, the most conspicuous of which are the goldenrods (*Solidago rigida, S. serotina, S. canadensis,* and other species), asters (*Aster patens, A. sericeus, A. multiflorus,* and other species), sunflowers (*Helianthus annuus,* and other smaller species). A few shrubs are found scattered over the prairies, adding to the variety of the vegetation, most noticeably the wild roses, redroot (*Ceanothus*), and shoe-string (*Amorphia canescens*), the last so called on account of its long tough roots which trouble the plowman.

The woodlands are usually found bordering the water courses. In some cases they constitute broad areas extending for many miles on each side of the streams, while in others they are narrow belts but a few rods in width, or even mere fringes along the stream-banks. The trees of the prairies are all of species which have wandered away from the eastern forests, and pushed up the streams to a greater or less distance. There are more species along the eastern side of the prairies, and their number decreases as we go westward. The common species are oaks, hickories, walnuts, willows, cottonwood, elms, maples and ashes. As a rule these trees are not as tall as those which occur in the heavy forests eastward, and they generally grow with more spreading tops. Occasionally, however, trees of gigantic dimensions are found in sheltered situations. Careful observation of the trees on the prairies shows that where they are protected from fires, stock and other adverse influences, they generally reproduce so rapidly as gradually to extend the forest areas. In many places the forest belts along the streams are widening, and also pushing up the valleys. Since the stoppage of prairie fires this natural spreading of the forests has gone on rapidly, so that there is to-day more forest-covered land in some parts of the prairie country than when it was first visited by white men.

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Prairie Chicken, or **Pinnated Grouse,** a familiar western gamebird (*Tympanuchus americanus*). The genus *Tympanuchus* (or *Cupidonia*) is particularly well characterized by a large patch of naked yellow skin on each side of the neck, ordinarily concealed by a tuft of narrow pointed feathers attached to the skin at its anterior border. Beneath this patch is an air-sac connected with the respiratory system and which can be inflated until the skin is distended to the size and form of half an orange. The head-crest is small, the tail is rather short, rounded and formed of 18 rather stiff quills, and the tarsi are incompletely and lightly feathered to the toes, which are naked and conspicuously webbed at the base. The plumage is plain, the colors being various browns and yellows with white and black, finely mottled above and more boldly barred transversely below. The neck-tufts of the male are 2½ to 3½ inches long, those of the female being considerably shorter. A full-grown male prairie-chicken is fully 18 inches long, but the females are smaller.

The changes in the centre of population of the prairie chicken as related to human settlement of the country are interesting and still in progress. Formerly it ranged throughout all open country between the Appalachian and the Rocky Mountain systems, and from Manitoba to the Gulf coast. As the country has become more thickly populated it has disappeared from many regions and the eastern limit of its range has moved more and more westward. At the same time the clearing of the forests has provided much new open country which it has been prompt to occupy, replacing other species of grouse less adapted to life on bare prairies, and becoming abundant in many places where, as in parts of Minnesota, the land is cultivated in large tracts. In this way its range has extended westward and northward as it has been curtailed eastward. Like most of the grouse the prairie chicken is gregarious, living in flocks which become very large in the winter, when the birds show a disposition to wander. Throughout most of its still wide range this species is not in any true sense migratory; but a definite northward and southward movement takes place in the upper part of the central Mississippi Valley, although according to some experienced gunners and ornithologists, this is limited to the females, the males being quite stationary. In the spring parties of the males congregate at dawn on knolls, perform various antics, and from time to time inflate and empty the air-sacs, thus producing a loud booming noise which is said to be audible, in the stillness of the time and place, for a mile. In a few days the females gather, when the cocks engage in fierce battles for the possession of mates, before whom they strut and swell, with drooping wings and spreading tail, with their Cupid's wings elevated and air-sacs inflated almost to bursting, until the conquest is complete. They are monogamous and the nest of grass and weeds is built in a concealed spot on the ground and from 12 to 20 eggs, of a grayish or buff color and either unmarked or speckled with brown, are laid. They are said to hatch in about 25 days and the young, which run at birth, are cared for chiefly by the female which has also performed the labor of incubation. Throughout the summer and early autumn they remain in family parties, but later gather in larger flocks. The food consists of various kinds of berries, nuts, seeds, shoots and buds, and insects. With the development of the prairie region as a great grain-growing country the prairie chicken has come to be especially abundant in the cultivated districts and to adopt wheat and other grains as special articles of diet. The vast numbers of grasshoppers which they destroy should, however, more than compensate the farmer for any loss of grain which he suffers.

The prairie chicken is so prolific, that, in spite of the enormous numbers destroyed annually by cold rains, hawks, skunks and other natural influences, and by man, it has held its own and continues to be abundant in many parts of the grain-producing prairie States. It is therefore of far greater commercial importance than all other species of our native grouse combined, and not only are immense numbers consumed within those States but many thousands are shipped to New York and other eastern markets, where its rich and delicate flesh is in demand for table use. Most States have seen the expediency of establishing close seasons and of prohibiting the use of snares and traps in its capture, so that it is now hunted almost exclusively with the shot-gun. Many States have also prohibited its shipment for sale and have limited the number which a gunner is permitted to shoot in one day, usually to 25 or 50. Naturally it is the great game bird of its range. Its great popularity with the masses, however, is probably due to the size of the bag which results from a day's shooting rather than to its gaming qualities, for in speed and other attributes which test the true metal of the sportsman the prairie chicken cannot compare with the ruffed grouse. Early in the season, when the young are not yet strong of wing and when better cover and warm weather cause the birds to lie close, bags of 50 or even 100 may be made by a good shot on the best hunting-grounds, but with the advance of the season and cooler weather the birds become more alert, harder and swifter of wing, the long quick shots which are now necessary testing the skill of even the most experienced gunner. Still later nothing but the rifle and much hard tramping is likely to yield any returns. As in the case of all similar gallinaceous birds, a strong shooting gun and good dogs are required. Whether the latter be setter or pointer is generally immaterial, as both may be equal in speed, ruse, and training. For this work on the wide, little watered prairies, endurance is a prime qualification and many hunters use their dogs in relays. The best time for the sport is in the early morning and late afternoon, not only because tramping under the noonday sun is very wearying to hunters and dogs, but also because the birds cease feeding at that time and retire to sheltered gulleys and ravines. The species is easily domesticated.

It is very commonly stated that the prairie chicken was found throughout the New England and Middle States a century ago; but ornithologists are now practically agreed that the eastern heath hen is a distinct species, properly called *T. cupido*. At one time it was common, but became practically extinct 75 years ago. At the present time the only colony known to be in existence is one which inhabits the wooded hills and scrubby plains of the island of Martha's Vineyard, where the birds are seldom seen in the thick coverts which this region affords. In general habits the heath hen differs little from its western relative. This remnant of its race is absolutely protected by the Massachusetts game law and a generally sympathetic local sentiment. A third species (*T. pallidicinctus*) is found in the region from Kansas to Texas, and along the Gulf coast the common prairie chicken develops a distinct local race in Texas and Louisiana. In parts of the Northwest the sharp-tailed grouse (*Pediocætes phasianellus*) (q.v.) is called prairie-chicken. See GROUSE.

Consult: Baird, Brewer and Ridgway, 'Birds of North America' (Boston 1887); Sandys and Van Dyke, 'Upland Game Birds' (New York 1902); Elliot, 'Gallinaceous Game Birds of North America' (New York 1897); Elliot, 'Monograph of the Tetraonidæ' (New York 1872); Palmer and Olds, 'Digest of Game Laws,' Bull. No. 16, Div. Biological Survey, U. S. Dept. of Agriculture, Washington 1902.

Prairie Dog, a name given to either of the two species of marmot-like rodents of the western plains of the genus *Cynomys*, but especially to *C. ludovicianus*. It is about a foot long, reddish-brown above, lighter beneath. Its habits are eminently social. It forms large communities on the higher and drier parts of the plains, each burrow having a little hillock at its entrance, forming a firm curb about the shaft, which leads steeply down to a series of chambers a dozen feet or more underground, where the animals spend the winter in comfort, sustained by a store of the stems and seed-heads of sunflowers and similar plants.

These colonies were naturally several acres in extent, forming "towns" of crowded burrows;

and were frequented by weasels, wolves, badgers, snakes, and birds of prey, which preyed upon the rodents and their young, and kept down their numbers. Since the general settlement of the borders and river-valleys of the plains region, the prairie dogs have been so favored by the decrease of their natural enemies, and by the spread of irrigated cultivated lands, supplying them with both water and food in vast abundance, that they have increased enormously, so that at the opening of the present century areas of thousands of square miles in northern Texas, and in the region between the upper Arkansas and Platte rivers, were so infected with the animals as to be practically useless to man. The question of practical relief from this condition has been a subject of much discussion among naturalists, not only, but both general and local governments have been forced to act in assistance of the farmers and cattlemen. The most successful means of extermination seems to be suffocation in their holes by means of bisulphide of carbon, which is placed upon balls of absorbent material and rolled down their burrows. Consult publications of the United States Department of Agriculture since 1891.

Prairie du Chien, Wis., city, county-seat of Crawford County; on the Mississippi River, and on the Chicago, M. & St. P., and the Chicago, B. & Q. R.R.'s; about 90 miles in direct line west of Madison. In the vicinity of the city are mineral springs. Prairie du Chien was settled in 1783, but a French fort was built here in 1689 and abandoned a few years later. Another fort was built in 1755. In 1786 the British surrendered this place to the United States, but captured it again in 1812 and retained possession for four years. In 1872 it was incorporated.

It is the trade centre of a fertile agricultural section. The chief manufactures are pearl buttons, barrels, veneer, egg cases, woolen goods, pickles, dairy products. The trade is chiefly in eggs, poultry, farm and dairy products, buttons and its own manufactures. The principal public buildings are the churches and schools; the ruins of Fort Crawford (1825) still remain. The educational institutions are College of the Sacred Heart, for boys and young men; Saint Mary's Institute, for girls; a high school, public and parish schools, and a public library. The population in 1910 was 3,149. Consult, 'Early Days of Prairie du Chien' in the 'Wisconsin Historical Society Collections,' Vol. V.; Durrie, 'Annals of Prairie du Chien.'

Prairie Fox, the swift or kit fox (*Vulpes velox*) of the western American plains. See Fox.

Prairie Grove, Battle of, an engagement between the Confederates under Gen. Hindman and the Federals under Gens. F. J. Herron and J. G. Blunt, at Prairie Grove, Ark., 7 Dec. 1862. Blunt had been stationed for some time at Cane Hill, when he received information that Hindman, with a force of over 11,000, was advancing northward to enter Missouri. He immediately summoned Herron and his two divisions, then near Springfield, Mo., to his aid. Herron reached Elkhorn, about 12 miles from Blunt's position, on the evening of 6 December, and the Confederates at that time lay between the two Union camps. Early in the morning of the 7th Hindman moved against Herron; the Confederate cavalry at first had the advantage, but were in turn driven back by Herron, whose entire force came up; Hindman then took up a strong position and awaited attack. Meantime Blunt hastened to Herron's aid, and Hindman thus faced a force superior to his own in both numbers and equipment. The battle lasted the greater part of the day, and the Confederates were finally forced to retreat. The Confederate loss in killed, wounded, and missing was 1,317; the Federal loss, 1,251. The battle was of importance as checking the further advance of the Confederates into Missouri.

Prairie Rattlesnake, the massasauga. See RATTLESNAKE.

Prairie-squirrel, or **Gopher,** a name for several animals of the genus *Spermophilus,* found in the American prairies in great numbers. See GOPHER.

Prairie State, a name applied to Illinois from the fact that the face of the State is mostly a level table-land, elevated from 300 to 800 feet above the sea.

Prairie Wolf, or **Red Wolf,** the coyote (q.v.).

Prajāpati, Hindu divinity, having the character of a creator, and in some way identical with Brahma, and with those divine personages who, under Brahma, created all things, including gods and demons. Thus there were many Prajāpatis, and the Puranas contain many legends concerning them. Consult: Hopkins, 'Religions of India' (1895); Macdonell, 'Vedic Mythology' (1897).

Prājñā Paramitā, the principal Sutra (body of rules or precepts) of the Mahayana School of Buddhists. The words mean in Sanskrit «absolute or transcendental wisdom.» See THEOSOPHY.

Prakrit, prä'krĭt, a general name applied to the old Hindu vernacular; the word means «of natural origin,» «vulgar,» in opposition to the classic Sanskrit («elaborated,» «perfect»). Prakrit is a daughter dialect of the old Vedic Sanskrit, from which it descends with mutilated forms, corruptions, and new constructions. It bears a different name in each district of India where it is current, such as Maharashtri Sauraseni, Magadhi, etc. Prakrit was early adopted into written literature and its forms fixed, while in the mouth of the common people it is differentiated into numberless dialects, such as Hindi, Bengali, etc. The main source of our knowledge of Prakrit is to be found in the Indian dramas, where women and people of the lower orders are made to speak Prakrit while kings, Brahmins, etc., use Sanskrit. The great Prakrit poem 'Ravanavâha,' was published by Goldschmidt (1880). Little was known of the Prakrit of Jainism, until Jacobi brought out (1878) 'The Kalpauhas of Bhadrabâhu,' a biography of the founders of that sect. Consult: Lassen, 'Institutiones Linguæ Prakriticæ' (1837); Muller, 'Beiträge zur Grammatik des Dechainaprakrit' (1876); Jacobi, 'Ausgewählte Erzählungen in Maharashtri' (1886).

Pram, prām, **Christen Henriksen,** Danish poet and critic: b. Lefta, Norway, 1756; d. island of Saint Thomas, W. I., 1821. He studied at Copenhagen and in 1781, as a member of the agricultural and commercial college of Copenhagen, he undertook several tours, the results of which were published in the 'Commercial Journal,' founded by him in 1782. In 1815 he was discharged from his office with small pension, and in 1819 became collector of customs on the island of Saint Thomas. His numerous writings embrace a great variety of subjects, both in political and natural science. Among his poetical productions are 'Heroide an Erich'; and 'Starkodder,' a heroic poem, in 15 cantos. Besides the 'Commercial Journal' he founded another, the 'Minerva,' a critical monthly which rendered essential service in the formation of literary taste in the Scandinavian kingdoms.

Prang, prăng, **Louis,** German-American engraver and publisher: b. Breslau, Germany, 12 March 1824; d. 15 June 1909. His part in the revolutionary movement of 1848 compelled him to leave Germany and he came to this country in 1850. He established himself as a wood-engraver in Boston, later becoming a lithographer, and in 1861 engaged in publishing, making a specialty of color printing. He invented the Prang method of art instruction and published the drawing books and materials used in that course. He was president of the Prang Educational Company of Boston and of the Taber-Prang Art Company of Springfield, Mass. He is author of 'The Prang Standard of Color' (1898).

Prase. See Quartz.

Prater, prä'tĕr, the most famous promenade of Vienna. See Vienna.

Prati, Giovanni, jō-vän'nē prä'tē, Italian poet: b. Dasindo, near Trent, 27 Jan. 1815; d. Rome, Italy, 9 May 1884. He wrote 'Edmenegarda' (1841), a narrative poem of the Romantic school, which was received with extraordinary favor. Several volumes of lyric poetry, still further increased the poet's reputation, but during the last years of his life he wrote but little. In 1862 he was elected to the Italian parliament and in 1876 became senator. His works include: 'Satan and the Graces' (1855); 'Count Riga' (1856); 'Rudolf' (1858); 'Aribert' (1860); 'Psiche' (1875); 'Iside' (1878); etc.

Prat'inas, Greek poet: flourished about 500 B.C. He was a native of Phlius in the Peloponnesus and became famous as a lyrical and dramatic poet. He is credited with originating the satiric drama which he introduced at Athens. Fragments of his lyrical poetry have been collected and published by Bergk in 'Poetæ Lyrici Græci' (1843).

Prat'incole, a genus *Glareola* of wading birds of the family *Glareolidæ,* allied to the plovers, inhabiting the temperate and warmer regions of the Old World. About half a dozen species are described in Europe, Asia, Africa, and Australia, frequenting the borders of rivers, lakes, and marshes, in low and in high regions; the food consists of worms and insects, which they pick from the ground or aquatic plants, or take on the wing like swallows; they fly and run very swiftly; the nest is a slight structure on the ground, among the thick herbage of the marshes, and the eggs three or four number. All scream noisily. The collared pratincole (*G. pratincola,* Pall.), plentiful in southern Europe, is about the size of a blackbird, nine inches long; it is brown above, white on the rump and below; the throat surrounded by a black circle; the base of the bill and the feet reddish.

Pratique, prät'ĕk, a term used to signify a kind of limited quarantine, which the captain of a vessel is held to have performed when he has convinced the authorities of the port that his ship is free from infectious diseases. See Quarantine.

Prato, prä'tō, Italy, city in the province of Florence; on the Bisenzio; 11 miles northwest of Florence. It is surrounded by ancient walls and is a well-built, cheerful-looking place. It has a court of justice, cathedral, begun by Nicolo Pisano, and completed after his designs in 1450 with a façade, furnishing a beautiful specimen of Italian Gothic; several other churches, monasteries, convents, an old castle, an ancient prætorium (Palazzo Pretorio), now a prison; a college, called after its founder Cicognini, a public library containing nearly 30,000 volumes, a theatre, and several hospitals; and extensive manufactures of woolen, cotton, silk, straw hats, paper, and articles in brass. Pop. about 53,000.

Prätorius, prā-tō'rē-ŭs, **Michael,** German composer: b. Kreuzberg, Thuringia, 15 Feb. 1571; d. Wolfenbüttel 15 Feb. 1621. Details concerning his life are of the briefest description. He began his career as kapell-meister at Lüneberg, was secretary to the Duke of Brunswick, and later was appointed prior of the monastery of Ringelheim, near Gozlar, with the privilege of making his residence where he chose. He was one of the most prominent composers of his time and also an able writer on musical topics. His most noted literary work is 'Syntagma Musicum' (1614–20), and his compositions include: 'Musæ Sioniæ' (published in nine parts, containing 1,244 vocal numbers); 'Missodia Sionia' (1611); 'Terpsichore' (1612); 'Puericinium' (1621); etc.

Pratt, prăt, **Anne,** English botanist: b. Strood, England, 1806; d. 27 July 1893. She made a life-study of the nature of plants and her writings reveal a wide knowledge as well as a deep love of nature. Her books are illustrated with her own excellent sketches and achieved great popularity. Among them are 'Flowers and their Associations' (new ed. 1840); 'Chapters on Common Things of the Seaside' (1850); 'Our Native Songsters' (1852); 'Flowering Plants, Grasses, and Ferns of Great Britain' (1854); 'Haunts of the Wild Flowers' (1863).

Pratt, Charles, American philanthropist: b. Watertown, Mass., 2 Oct. 1830; d. New York 4 May 1891. He obtained a portion of his education at Wesleyan Academy, Wilbraham, Mass., and in 1851 removed to New York where he engaged with a paint, oil, and glass firm of which he became a member in 1854. When the firm dissolved in 1867 he retained the oil interests and under the firm name Charles Pratt and Company organized a most successful business. He grasped the possibilities of the petroleum trade when the oil fields of Philadelphia were being developed in 1860 and devoted himself to producing the best quality of refined petroleum on the market, Pratt's astral oil becoming world-famous. He acquired an enormous fortune and his business was eventually merged in the Standard Oil Company. He afterward devoted himself to philanthropic enterprises and contributed generously to various religious, charitable, and educational causes. His greatest philanthropic work was the founding of the famous Pratt Institute in 1886 in which he embodied his ideas of a thorough and practical education. It was opened in 1887 with 12 students, a number which at the time of his death had increased to over 3,000. The entire cost of the buildings, equipment, grounds and ample endowment was borne by Mr. Pratt and at his death left a further endowment of $2,000,000. He was public-spirited in every way but firmly declined public office.

Pratt, Daniel, the «Great American Traveler,» American eccentric: b. Prattville, Chelsea, Mass., about 1809; d. Boston, Mass., 21 June 1887. He was a carpenter by trade, but became mentally unbalanced, and wandered about, a pensioner on general charity. Contributions of his, including certain «proclamations,» appeared from time to time in print; and for several years he made a grand tour of New England colleges, delivering in each grandiloquent orations. He believed himself unjustly deprived of the presidency, asserting he had been duly elected.

Pratt, Ella Farman, American writer for young people: b. New York; d. Warner, N. H., 22 May 1907. With C. S. Pratt, for a series of years she edited the juvenile periodical 'Wide Awake,' and, more recently, 'Little Folks.' Among her books, many of which were published under her maiden name, are 'Good-for-Nothing Polly'; 'How Two Girls Tried Farming'; 'A Girl's Money'; 'The Cooking Club of Tu-Whit Hollow.'

Pratt, Enoch, American philanthropist: b. North Middleborough, Mass., 10 Sept. 1808; d. near Baltimore, Md., 17 Sept. 1896. He was educated at the Bridgewater (Mass.) Academy, entered a commercial house in Boston, and in 1831 removed to Baltimore where he became a wholesale iron merchant and engaged in various financial enterprises which gained for him enormous wealth. He presented to the city of Baltimore in 1882 the Pratt Free Library; gave generously to different churches, libraries, and schools, and founded the House of Reformation and Instruction for Colored Children at Cheltenham, Md., and the Maryland School for the Deaf and Dumb at Frederick.

Pratt, John Francis, American scientist: b. Pomfret, Vt., 18 June 1848. He was graduated from Dartmouth College in 1871; studied civil engineering and in 1871 became connected with the United States Coast and Geodetic Survey, being made an assistant in 1884. He led the expedition to Chilcoot, Chilkat, Skagway, and Dyea to determine the southeast boundary of Alaska; conducted an expedition to the east side of Bering Sea and the lower portion of the Yukon River in 1898, and since 1899 has commanded the United States steamship Patterson. He has conducted various expeditions to Alaska and Bering Sea.

Pratt, Orson, American Mormon apostle: b. Hartford, N. Y., 19 Sept. 1811; d. Salt Lake City, Utah, 3 Oct. 1881. After a common-school education, he joined the Mormons in 1830, accompanied them in the westward migration, and in 1835 became one of the 12 apostles. With Erastus Snow, he was the first to enter the valley of the Great Salt Lake. In 1840–78 he accomplished eight missions to Great Britain, and in 1865 one to Austria. He began in Washington in 1852 the publication of 'The Seer,' a monthly, of which 18 numbers appeared. He was for many sessions a member of the Utah territorial legislature, and seven times its speaker. A scholar in the higher mathematics, he held the chair of that subject for a time in Deseret University, and in 1854 announced his «law of planetary rotation» — that the cubic roots of the densities of the planets are as the square roots of their periods of rotation. Among his works are: 'Cubic and Biquadratic Equations' (1866); 'Key to the Universe' (1879); and 'The Absurdities of Immaterialism.'

Pratt, Parley Parker, American Mormon apostle: b. Burlington, N. Y., 12 April 1807; d. near Van Buren, Ark., 13 May 1857. He adopted the Mormon faith in 1830 and in 1835 was elected a member of the first quorum of the 12 apostles. He traveled in this country and in England engaged in missionary work, and established at Manchester, England, the 'Millennial Star.' He was one of the party which explored the valley of the Great Salt Lake in 1847 and 1849, and Parley's Peak and Parley's Cañon were named in his honor. He afterward made a proselyting tour to the Pacific coast and while occupied in a similar tour in the east was murdered near Van Buren, Ark. He wrote: 'The Voice of Warning' (1837); 'History of the Persecutions in Missouri' (1839); 'Key to the Science of Theology' (1854); etc.

Pratt, Samuel Jackson («COURTNEY MELMOTH»), English author: b. St. Ives, Cornwall, 25 Dec. 1749; d. Birmingham 4 Oct. 1814. He was ordained in the English Church, but later went on the stage where his career was not notable and then turned his attention to literature. He translated Goethe's 'Sorrows of Werther' (1813), and wrote among many other works: 'Tears of Genius' (1774); 'Liberal Opinion' (1775); 'Apology for David Hume' (1777); 'Gleanings through Wales, Holland' (1795); 'The Fair Circassian,' a tragedy; 'Cabinet of Poetry' (1808); etc.

Pratt, Silas Gamaliel, American composer: b. Addison, Vt., 4 Aug. 1846. He studied in Berlin in 1868–71, and upon his return to America gave his first symphony concert in 1871 and in the following year organized the Apollo Club of Chicago. His opera 'Zenobia' was well received on its presentation in 1882; and in 1884 he was director-general of the Chicago Grand Opera Festival. In 1890 he accepted an appointment as professor of piano at the New York Metropolitan Conservatory. He has published numerous songs, part-songs, symphonies, etc., besides the operas: 'The Triumph of Columbus,' and 'Lucille.' He has also written: 'Lincoln in Story' (1901); and 'Pianist's Mental Velocity' (1903).

Pratt Institute, a polytechnic school in Brooklyn, N. Y., established in 1887 by Charles Pratt. Its aim is to promote manual and industrial education as well as cultivation in literature, science, and art. Its organization includes the following departments: (1) The High School; (2) the Department of Fine Arts; (3) the Department of Domestic Art, including courses in dressmaking, millinery, art needlework and costume design; (4) the Department of Domestic Science, including courses in cookery, serving, and laundry work; (5) the Department of Science and Technology; (6) the Department of Kindergartens; (7) the Department of Libraries, including the library and the library school; (8) the Department of Physical Training. The High School course includes physical and manual training, and prepares for college. The regular courses of the Institute vary in length; mostly they are two or three years in length; the general course in domestic science is only one year, and the general art course four years. Normal courses are given in the departments of Fine Arts, Domestic Art and Domestic Science; evening classes, in the departments of Fine Arts, Domestic Art, Domestic Science, and Science and Technology. The Kindergarten Department provides kindergarten training for children from three to six years old, and also a two years' normal course, and a course for mothers. The library is open for the free use of the public, has a large children's room, and in equipment and management is considered a model library. It contained 100,000 volumes in 1910. The library school offers a one-year general course and a second-year special course, and provides practice work for students in the library (see LIBRARY SCHOOLS). The institute confers no degrees, but grants diplomas for the completion of the high school course and any of the normal courses; and gives certificates attesting the completion of the full-time day courses. It occupies seven large buildings, the Main Building, the Science and Technology Building, the Electrical Building, the High School, the Kindergarten Building, the Library, and the Gymnasium. The endowment is large and the tuition fees are small; in 1910 the productive funds amounted to $4,750,000. The students of that year numbered 3,773, including all those in the special and evening, as well as the regular courses.

Pratz, Le Page du, lė päzh dü präts, French explorer in the New World: b. Holland about 1690; d. 1775. Entering the French army and serving in Germany for a time he was subsequently a member of the French Compagnie d'Occident which acquired a grant of territory near New Orleans, La. Du Pratz led an expedition there in 1718 and made unsuccessful attempts to found a colony. In 1720 he went up the Mississippi and settled among the Natchez Indians. Later he explored the region bordering the Mississippi and Arkansas and was for some years treasurer of the land company at New Orleans. He returned to France in 1734 and his valuable 'History of Louisiana' was printed in 1758.

Prawn, a small decapod crustacean of the family *Palæmonidæ*, allied to the shrimps, in which the beak or «rostrum,» which projects in front of the carapace, is large, toothed, and of compressed shape. The common British prawn (*Palæmon serratus*) is three to five inches long, shrimp-like in form, half-transparent and often beautifully tinted, and is taken for market in great quantities by means of nets operated on sandy shores. When boiled, prawns become of a pale pink color, and are highly esteemed as table delicacies in this and in other shapes. Several species occur on the eastern coast of the United States, but are little used.

Prax'eas, a teacher of the errors of the Antitrinitarians or Monarchians. Toward the end of the second century, after suffering persecution in the reign of Marcus Aurelius for his open confession of the Christian faith, he came to Rome from his native Phrygia to acquaint Pope Victor with the erroneous teachings and vicious practices of the Montanists, and prevailed upon Victor to recall the letters of communion which he had given to those sectaries. But while at Rome and afterward in Africa he became an apostle of the doctrine of the Monarchians, teaching that in the Godhead is but one Person, who proceeding forth of his own divine essence and called Son, entered the Virgin's womb, was born of her and suffered on the cross: hence the distinctive name of the sectaries who followed Praxeas — Patripassians.

Praxiteles, prăks-ĭt'ĕ-lēz, Greek sculptor: b. probably about 400 B.C. He was the contemporary of Scopas, and one of the greatest sculptors of ancient times. The date of his death is unknown; but his life must have been long since nearly three score works are mentioned as executed by him. He lived in the age of greatest opulence in Greek art, an age succeeding that of Phidias and one which had outgrown the austere vigor displayed in the works of the earlier master. During the time of Praxiteles the life of the individual was less merged in that of the body politic, and became more highly developed. This fact consequent upon the growth of wealth in private possession made the work of the sculptor in demand for the adornment of private houses instead of temples of worship. Praxiteles worked for private buyers, and many of his statues went to Asia Minor as well as Greece. Antiquity placed the highest estimate upon his statue of Aphrodite, and people traveled in large numbers to Cnidus to see it. Lucian records seeing it there about 150 A.D. The statue has disappeared, but an idea of its form may be derived from a Cnidian coin, bearing its effigy, struck in honor of Plautilla. The greatest of his extant works is the statue of the youthful Hermes bearing on his arm the infant Dionysus. This statue, described by Pausanius, was discovered by German excavators, at Olympia, where it now remains. The face, which is perfectly preserved, gives to posterity a revelation of the exquisite beauty of the Greek face. The mutilated statue of Demeter from Cnidus, now preserved in the British Museum, is probably by Praxiteles; but the Hermes is the only unquestionable one. Pausanias records that Praxiteles regarded his statue of Eros and one of a satyr as his greatest works. This Eros was presented to Phryne, the courtesan, who posed for the Cnidian Venus, and was afterward placed in the temple at Thespiæ. There was another Eros at Parium on the Hellespont. The Satyr, represented leaning gracefully with his arm on a support, is preserved in reproduction in the Capitoline Museum at Rome, and furnished Hawthorne with his inspiration for his romance, 'The Marble Faun.' The 'Apollo Sauroktonos' (Lizard-Killer), a motive original with Praxiteles, is also known to posterity in reproductions in the Louvre and elsewhere. Praxiteles produced in addition to statues portrait busts and genre-scenes, the latter being in the form of sculptured reliefs upon tombs was a special product of the art of his age. His work, which exercised a great influence upon the further development of Greek art, charms by its perfection of grace, and its refined and noble expression of human emotions. Consult: Kekulé, 'Der Kopf des Praxitelischen Hermes' (1881); Klein, 'Praxiteles' (1898).

Praya, prä'yä, or **La Praya,** Cape Verde Islands, capital of the group of Portuguese islands; on the southeast coast of the island of Santiago. It has a good harbor and commercial relations with all the cities of the island. Pop. estimated, 5,000.

Prayer, a human address made with the expectation of its being heard and answered to an invisible and omnipotent Supreme Being. In every time and place men have felt their dependence on a higher Being, and have sought his assistance in prayer.

The Scriptures tacitly assume that prayer was offered to God from the beginning of the world; there were sacrifices from the time of Abel, and where there were sacrifices there must also have been sacrificial prayers. It is not, however, until the time of Abraham that prayer first comes distinctly into notice. His devout faith prompted him to build an altar wherever he remained, and to call upon God. He was doubtless a priest within his own family and household, and they participated in his services and obtained the benefit of his intercessions. As the altar appears to have been considered the special place for prayer in the patriarchal age, so was the tabernacle under the Mosaic covenant until the temple was built, which was called the house of prayer. From the time of the dedication of Solomon's temple the Jews appear to have gone there to pray, and to have turned their faces toward it if they were prevented from going there; and this custom prevails among the Jews at the present time, as does the similar custom among the Mohammedans, who turn their faces toward the sacred Kaaba at Mecca. On examining the character of the prayers mentioned in the Old Testament we find that, with the exception of many of the Psalms, they were principally petitions for temporal objects. This is suited to the purposes for which the historical books of the Jewish Scripture were written, as the Mosaic covenant pledged God to confer temporal benefits on his people when they called upon him. We find also that a great number of them are intercessory; thus we have Abraham interceding for Lot, Moses for the people, Samuel for the people and for Saul, David for his nation, Elisha for the dead child, and so on. When we come to New Testament times we meet for the first time with synagogues established as places for the public worship of God, and for reading his word. The leaders in religion — the priests, scribes, and Pharisees — were no longer the faithful servants of God they once were. Christ announced toward the close of his ministry that prayer should be offered to God in his name in order to insure an answer. The posture of the body in prayer is left undecided in Scripture; both standing and kneeling are mentioned, and Christ adopted both postures. By giving his disciples a form of prayer Christ implied that there are times when these are useful.

Prayer for the dead prevails in the Roman Catholic, Greek, and other Eastern churches. The custom seems to have existed in most of the ancient religions, especially in those of India, China, and Egypt. The doctrine and practice came to the Christian Church through the Jews (2 Maccabees xii. 43, 45). The first of the Christian fathers who mentions prayer for the dead is Tertullian; but he speaks of the usage as well-known and long-established in the church; such prayers are frequently alluded to by St. John Chrysostom, Cyril of Jerusalem, and St. Augustine. In the burial service of the first Book of Common Prayer of the English Church some prayers for the dead appeared, but they were deleted from the second book, and are not found in the subsequent revisions.

Prayer Beads, the polished seeds of a West Indian leguminous plant (*Abrus precatorius*) called wild licorice. These seeds were formerly much used for stringing into rosaries, necklaces, etc.

Prayer Book, the Anglican Book of Common Prayer. See COMMON PRAYER, BOOK OF; BREVIARY.

Prayer Book, Common. See COMMON PRAYER, BOOK OF.

Prayer, Week of, a special period of devotion set apart for the first time by the Presbyterian missionaries of Lodiana, India. A call to a universal observance of this week was issued by the missionaries late in 1859, and the appeal met with a hearty response in January 1860; since which time the week of prayer has become a settled institution among Protestants.

Praying Indians, The, in American colonial history, the name given those New England Indians who were early won to the Christian faith. During Philip's war they remained friendly to the colonists, a company of them enlisting under Major Gookin in July 1675. They acted as scouts and spies and rendered valuable service against Philip.

Praying Insects. See MANTIS.

Pre-Ad'amites, those supposed inhabitants of the earth prior to the creation of Adam. The legendary traditions of the East speak of nations and empires existing before Adam's creation, and of a line of kings who ruled over them. In modern times the subject was taken up by Isaac de la Peyrère, who, in a work published in 1655, maintained that the Jews were the descendants of Adam, and the Gentiles those of a long anterior creation, founding his opinions on Genesis iv. 14, 17; and Romans v. 12–14.

Pre-Cam'brian Formations. Those geological formations included in the systems below the Cambrian are sometimes grouped under this name. In America they include the earliest formations, namely, those of the Archæan Period (q.v.), and those immediately succeeding them, namely, those belonging to the Algonkian System (q.v.). According to the earlier, European, nomenclature all the Pre-Cambrian formations fell within the Archæan Period, their lower series being called the Laurentian and the higher the Huronian. The latter practically correspond to the Algonkian.

The time occupied by the deposition of the Pre-Cambrian formations extended from the solidifying of the crust of the earth to the beginning of the Cambrian Period (q.v.) and as the first traces of life are found in these formations, and as they already show in the variety of their types evidences of long development, the length of time that elapsed during the building up of these formations must have been very great. See GEOLOGY; CAMBRIAN SYSTEM.

Pre-emp'tion Law, United States. The first pre-emption act was passed 3 March 1801; it was a special act affecting the Symmes colonization scheme on the Miami River. Between that time and 1841 about 18 pre-emption acts were passed, all of a more or less special nature. The first general law was passed in 1830. That of 1841, which is now in force, grants, upon considerations of residence and improvement, freedom of entry upon 160 acres of public lands to any person over 21 years of age. One to three years are allowed for payment, and the amount varies with the value and situation of the tract pre-empted.

Pre-exis'tence, the doctrine that the soul of an individual had an existence previous to that of the body in which it appears. This opinion was very prevalent in the East, and was held by the Greek philosophers, Pythagoras, Empedocles, and Plato himself. A similar doctrine has found some countenance in Christian times among those who were anxious to explain how the soul becomes united to the body, but could not divine any more plausible hypothesis than that all souls were created before the world, and that each has its proper body allotted to it at the time of birth. In opposition to doctrine of pre-existentism is that of traducianism, which teaches that the soul, like the body, is propagated; and creationism, in accordance with which a new soul is immediately created out of nothing by God for each newly propagated body.

Pre-Raphaelites, members of the «Pre-Raphaelite Brotherhood» and their followers. The original brotherhood was founded by the association of three painters, Dante Gabriel Rossetti, William Holman Hunt and John Everett Millais. The inspiration, however, which gave life to the Pre-Raphaelites was derived from an artist who never joined the brotherhood, Ford Maddox Brown. In 1848 Rossetti became the pupil of Maddox Brown, a great and original artist whose work was quite neglected at a period when Victorian art in England had sunk to its lowest condition of commonplace prettiness, conventionality and utter want of mysticism or spirituality. Maddox Brown, the practical originator of the new school of English painting, and the bringer-in of a new English Renaissance, had attracted the notice of Rossetti by his powerful picture, 'Parisina's Sleep,' which was exhibited at the British Institution 1845 and was conspicuous for marvelous atmosphere, finish and fidelity of expression. Rossetti became the devoted disciple of this master. Rossetti was a poet, full of dreams and desires, and passionately striving after the true and the beautiful. At the academy schools he met William Holman Hunt, a man of profound religious feeling, yet reserved, hard working and bound on notable and original achievement in art. With them was eventually associated John Everett Millais, already a brilliant and successful artist, and far in advance of his confrères of equal age in all the skill that comes from knowledge and practice. These men, strangely different in artistic temperament, formed a powerful trio devoted to making a fearless protest against the shallow and insincere banalities of the day. They called themselves Pre-Raphaelites; but, as Holman Hunt has said, «Neither then nor afterward did they affirm there was not much healthy and good art after the time of Raphael; but it appeared to them that afterward art was so frequently tainted with the canker of corruption that it was only in the earlier work they could find with certainty absolute health. Up to a certain point the tree was healthy: above it, disease began; side by side with life, there was death.» Their artistic doctrines were indeed to be summed up in the one word *sincerity;* the bond of union between them, as enunciated by one of their number was (1) to have clear ideas to express; (2) to study Nature attentively, so as to know how to express them; (3) to sympathize with what is direct and serious and heartfelt in previous art, to the exclusion of what is conventional and self-parading and learned by rote; and (4) most indispensable of all, to produce thoroughly good pictures and statues.

The three founders of the association which Maddox Brown had originated were subsequently joined by Thomas Woolner, sculptor; James Collinson, painter, who eventually left the brotherhood; Walter Howell Deverell, painter; Frederick George Stevens, painter; and William Michael Rossetti, younger brother of Dante Rossetti, and like the latter, a poet. Maddox Brown declined to join simply because he disliked coteries, and it certainly was not he who gave the doctrine its name of Pre-Raphaelism. But, as his own work was an embodiment of this artistic creed, so his association with the members of it was always close and his sympathy with their work enthusiastic. Millais remained in the brotherhood 10 years (1849-59); he then dropped out, became a fashionable portrait painter and famous for his power in painting children, and such textures as satin and velvet. Holman Hunt kept on an uncompromising adherent to the principles of the brotherhood. But before the work the Pre-Raphaelites had to do was accomplished, they were compelled to run the gauntlet of criticism and ridicule from those whose system and method of painting they were attacking. In the *Times* of 5 May 1854 a letter appeared signed by John Ruskin, boldly praising and defending the new school. It is doubtful, however, whether Ruskin understood the principle of Pre-Raphaelism, and it is a mistake to think that his writings gave the first suggestion for the formation of such a league.

Pre-Raphaelism has become a permanent influence in English art. The generation of English artists which succeeded that in which Maddox Brown lived have followed the guidance of the Pre-Raphaelites, either as to romantic motif, mystic religiousness, or drawing and technique; sometimes in all of these. In certain quarters, however, there has appeared a tendency in a somewhat perverted manner to carry out the traditions of the brotherhood, by an exaggerated mediævalism, a deliberate crudeness or grotesqueness of design, and an insistence on minute detail. Consult: Bate, 'The English Pre-Raphaelite Painters' (1901); Quilter, 'Preferences in Art Life and Literature' (1892).

Preachers, Orders of. See Dominicans.

Preaching Friars. See Dominicans.

Préault, prā-ō, **Auguste,** French sculptor: b. Paris 8 Oct. 1809; d. there 11 Jan. 1879. He began his art studies with a decided tendency toward romanticism and entered the studio of David d'Angers, but soon left it and ever afterward aimed at a naturalistic treatment of art themes. This was proved by the first works he exhibited at the Salon (1833) — 'Misery,' a group representing a girl dying in the arms of her mother; and two reliefs, 'Death of the Poet Gilbert in Hospital' and 'Famine.' In the following years he exhibited numerous works, among them the statue 'Undine'; and the relief 'River Amazon'; 'Queen of Sheba'; a sitting figure of Hecuba; the colossal statue 'Charlemagne'; and the statue 'Carthage.' These works were not admitted to the Salon, but in 1848 the opinion of his merits had changed and the doors of the exhibition in the Champs Elysées were opened to him, and he was represented there by his 'Christ on the Cross' (now in the Church of Saint Gervasius); the relief 'Ophelia'; the sepulchral monument of Saint Roque (in the church of that dedication); the statue of 'General Marceau' at Chartres (1850); and the statuette 'French Comedy.' As a sculptor his workmanship was fine, but he sometimes failed to control his fancy and strong feeling for realistic form within that reserve and restraint prescribed by the canons of strictly plastic art.

Preb'end, a stipend paid to an ecclesiastic from the foundation funds of a cathedral or collegiate church. Prebendary is the person who holds a prebend. A simple prebend has no more than the revenue which is assigned for its support; but if the prebend has a jurisdiction annexed, the prebendary is styled a dignitary. Prebendaries, as such, have no cure of souls; and therefore a prebend and a parochial benefice are not incompatible promotions. The prebendal stall is the seat of the prebendary in the church, into which he is inducted by the dean and chapter.

Preble, prĕb'l, **Edward,** American naval officer: b. Portland, Maine, 15 Aug. 1761; d. there 25 Aug. 1807. When 17 he ran away from home and joined a privateer, and on his return entered the Massachusetts State marine as midshipman on the Protector and participated in the attack on the British privateer Admiral Duff which was destroyed. In 1779 he was captured on board the Protector and imprisoned on the Jersey prison-ship in New York harbor. Upon his release he served on the Winthrop and with 14 men boarded an armed British brig and took her out of Penobscot harbor in the face of the enemy's battery. On the organization of the United States navy in 1798 he was one of the first five to be commissioned lieutenant, and in 1799 was promoted captain in command of the Essex with which he convoyed a fleet of 14 valuably laden merchantmen to China. In 1803 he was assigned to the Constitution and given command of the squadron against the Barbary powers. He arrived at Tangiers in October 1803 and speedily forced from the Sultan of Morocco a renewal of the treaty of 1786. The Philadelphia of his squadron was captured while pursuing Tripolitan gunboats and Preble blockaded Tripoli for several months endeavoring to regain or destroy the ship. In July 1804 he bombarded Tripoli and subsequently conducted six vigorous attacks in which he captured three gunboats and sunk three others. In September the relief squadron under Preble's senior officer, Captain Barron, arrived and Preble was relieved. The treaty was signed in 1805 without further fighting and Preble received a gold medal and the thanks of Congress.

Preble, George Henry, American naval officer: nephew of Edward Preble (q.v.), b. Portland, Maine, 25 Feb. 1816; d. Boston, Mass., 1 March 1885. He entered the navy as midshipman in 1835, served in the Mediterranean on the frigate United States in 1836-8, was engaged in the war against the Seminoles in 1841-2, and in 1843-5 circumnavigated the world on the Saint Louis, attaining the distinction of landing the first American force in China. In the Mexican War he participated in the battles of Alvaredo, Vera Cruz, and Tuxpan; in 1848 was promoted lieutenant and in 1854-5 was engaged in several actions with Chinese pirates. In 1862 he commanded the steamer Katahdin under Farragut at the capture of New Orleans, was commissioned commander in that year and for failure to capture the Confederate cruiser Florida was dismissed from the navy. Investigation proved him blameless, however, and he was restored to his rank, placed in command of the Saint Louis with which he engaged in pursuing Confederate rovers in foreign waters. He was commissioned commodore in 1871, and in 1873-5 had charge of the navy-yard at Philadelphia. In 1876 he received rank as rear-admiral, was in command of the South Pacific station in 1877-8, and in 1878 was retired. He wrote: 'Chase of the Rebel Steamer of War Oreto' (1862); 'History of the American Flag' (1872); 'History of Steam Navigation' (1883); etc.

Prece'dence, in official life, the order in which men and women follow each other according to rank or dignity in a State procession or on other public occasions. In England the order of precedence depends partly on statutes, and partly on ancient usage and established custom. Questions arising on matters of precedence depending on usage are hardly considered as definitely settled, and are in a great measure left to the discretion of the officers of arms. The sovereign, of course, is always first in order of precedence, after whom in descending order follow the Prince of Wales, sons of the sovereign, grandsons of the sovereign, brothers of the sovereign, uncles of the sovereign, the sovereign's brothers' or sisters' sons, the Archbishop of Canterbury, the Lord High Chancellor, and so on through the high state dignitaries, the various ranks of the peerage, etc. The order of precedence among women follows the same rules as that among men. By the acts of Union of Scotland and Ireland the precedence in any given degree of the peerage has been established as follows: (1) Peers of England; (2) Peers of Scotland; (3) Peers of Great Britain; (4) Peers of Ireland; (5) Peers of the United Kingdom and Peers of Ireland created subsequent to the Union.

In the United States the most generally accepted order in Washington official life is as follows:

- The President,
- The Vice-President,
- President of the Senate,
- Foreign Ambassadors,

Chief Justice of the Supreme Court,
United States Senators,
Speaker of the House,
Representatives in Congress,
Associate Justices,
Secretary of State,
Diplomatic Corps (other than ambassadors),
Secretary of the Treasury,
Secretary of War,
The Attorney-General,
The Postmaster-General,
Secretary of the Navy,
Secretary of the Interior,
Secretary of Agriculture,
Secretary of Commerce and Labor,
General Staff of the Army,
Admirals of the Navy,
Governors of States.

Then follow the judiciary, army and navy officers, chiefs of departments, foreign consuls, secretaries of legations, etc.

Precen'tor (Latin, *præ*, before; *canere*, to sing), a leader of singing. In cathedrals of ancient foundation of the Established Church of England the precentor is a member of the chapter, and in dignity ranks next after the dean; in cathedrals of the new foundation, that is, those of sees created by Henry VIII. or formed in later times, the precentor is only a minor canon and is removable at the pleasure of the dean and chapter. During solemn functions the precentor's place is on the north side of the chancel, while that of the dean is on the south side. In the Presbyterian churches of Scotland it was formerly the custom that half an hour before the arrival of the minister, the precentor would read to the congregation lessons from the Scripture; when the minister entered, the precentor would give out a psalm and lead the singing; hence his desk, below the pulpit, is still called lectern, or in Scotch dialect *lettran*, that is, reading-desk. In the rural districts of Scotland it is still customary for the precentor to read each verse of a psalm before it is sung.

Precession of the Equinox. See EQUINOX.

Précieuses Ridicules, Les, lā prā-sē-ē rē-dē-kül, a comedy by Molière, produced for the first time 18 Nov. 1659. No one of Molière's comedies is better known than this famous satire on the ‹Précieuses,› which can almost be entitled a farce, being an exaggeration of an exaggeration. It is in one act, and is a satire on a style of speech, and an affected taste in art and literature, prevalent among a certain class at that time. When writing it, Molière had in mind the literary lights who assembled at the Hôtel de Rambouillet.

Precious Metals, gold and silver are commonly included under this term, though platinum and quicksilver have sometimes been added. However, on the basis of their having sufficient value and being abundant enough for coinage, gold and silver are more accurately described as precious metals. America has contributed largely to the total amount of the precious metals in circulation in the world. The subjoined table exhibits some interesting comparisons in the production of precious metals by the United States and by Mexico and Australasia, the three countries which rank highest in annual total production of these metals according to their monetary value.

Fine ounce of gold, $20.671834 +; fine ounce of silver, $1.292929 +, coining rate in United States silver dollars.

The United States, therefore, while greatly surpassed in the amount of gold produced by Africa, and in silver by Mexico, far surpassed every other country in the total value of precious metals produced in 1908–9.

The total amount of precious metals for 1908–9 was for the world, 215,064,840 ounces fine; Mexico, 74,746,237 ounces fine; U. S. 59,543,201 ounces fine; Australasia, 20,722,309 ounces fine; Africa, 9,328,025 ounces fine.

Precious Star, Order of. See ORDERS, ROYAL.

Precious Stones. See GEMS.

Precip'itate, in chemistry, a solid body produced by the mutual action of two or more liquids. Thus if sulphuric acid be added to an aqueous solution of barium chloride, barium sulphate is produced, and being insoluble in the menstrua present it precipitates or sinks as a solid to the bottom of the liquid in the vessel. So again, if a solution of potassium iodide be added to a solution of lead chloride, a reaction takes place resulting in the formation of lead iodide and potassium chloride, and inasmuch as the former of these bodies is, under the circumstances, a solid, it is precipitated. As a general rule it may be laid down that if it is possible to produce a solid substance by the action of two liquids on one another, that solid will be produced when these liquids are mixed, and that therefore a precipitate will be formed.

Predestina'rians. See RELIGIOUS SECTS.

Predestination is the doctrine of God's will and counsel as revealed in the decreed redemption of mankind. It includes in its scope two significant facts, namely, his beneficent and all-wise purpose and plan in reference to those who are fore-known and fore-chosen to the enjoyment of eternal salvation; and his fixed, determinate attitude toward those who are permitted to perish in their sins. This doctrine, as thus defined, has been the subject of intense theological controversy, because of the many essential and apparently contradictory personal features involved in it. And yet its history, as it appears in the rise and development of Calvinism over against Pelagianism gives evidence of the logical connection which it has with biblical and metaphysical truth.

The sources of this tenet are set forth in the Old and New Testament Scriptures. From the earliest times of the human race; the God who «upholds, directs, disposes, and governs all creatures, actions, and things, from the greatest

PRODUCTION OF GOLD AND SILVER, 1908–9.

	Gold		Silver		Total value of precious metals
	Oz., fine	Value	Oz., fine	Value	
United States	4,821,701	$99,673,400	54,721,500	$28,455,200	$128,128,600
Australasia	3,547,210	73,327,300	17,175,099	9,187,000	82,514,300
Mexico	1,082,210	22,371,200	73,664,027	39,402,900	81,774,100
Africa	8,055,430	166,520,500	1,272,595	680,700	168,301,200
The world	3,871,929	80,039,800	46,853,149	30,958,601	110,998,401

even to the least," is manifestly a potent personal factor in the world. His wisdom and might, his love and grace, are wondrously and sublimely illustrated in the lives and movements of his chosen people. Every stage of their history, in the genesis and growth of their civil and religious institutions, to the closing tragedy of the life of Jesus Christ, furnishes a series of pictures of the divine method of government, as they are painted by his artist hand. Indeed, so evident is his own mind and purpose throughout the execution of his salvatory plan, that his nature, life, and love at once and forever become inseparable elements within the domain of the human universe. And this is fully indicated (1) by the perfection of his nature; (2) in the marks of his infinite wisdom, power, holiness, etc.; (3) in the operations of his will, thought, and counsel; (4) in prophetic utterances and their fulfilment; (5) in the coming of Jesus Christ, the true representative of God; (6) in the unchangeable provisions of the redemption wrought out through him; (7) in the actual salvation of men from their sins; (8) in the establishment, upon a sure foundation, of the *Fact* of eternal life!

The historic birth of this doctrine can be traced to the fertile brain of Origen, who possibly was its first supporter, although he did not fully accept the second portion of it, which consigns the unsaved to conditions of everlasting reprobation. From his time to the Augustinian Age there was little controversy over the sovereignty of God in its relation to man's freedom and salvation. But during Augustine's sway, in the Western Church, the doctrine of man's inability to save himself and his absolute dependence upon God's eternal decree to be saved, was so strongly and vigorously taught that Pelagius, who represented opposite theological tendencies, declared that the true fundamental conception of sin involved man's capacity of choice to be good or evil, apart from God's plan and grace. This controversy was waged with great earnestness — especially in the Greek Church — for half a century, till it was modified under the form of Semipelagianism.

Later theologians divided themselves into two groups, the Infralapsarians and the Supralapsarians. The former taught that the decree of predestination had no effectiveness until after man's fall, while the latter class held that the ultimate end which God had in mind was his own glorification in the salvation of some and in the reprobation of others.

During the Reformation the strongest exponents of the true predestination idea were the Calvinistic thinkers under the leadership of John Calvin (1509), though the Lutherans and Arminians also accepted the doctrine in a less rigid form. Calvin's doctrinal ideas were incorporated in his greatest masterpiece, 'Institutes of the Christian Religion' (1535). The main features of this scholarly production, aside from the dissertations upon church, state, and religion, are embodied in the doctrines of plenary inspiration of the Bible, free-will, and predestination. Here God is the centre and man the object of his voluntary interest and love. But in this relation he is confessedly to be dealt with according to his Creator's established order. Everything in and about him which is out of harmony with that order must be adjusted or rejected. In this process of correction or of salvation God acts alone. Man is a passive agent without the power of free-will. His predestinated salvation or reprobation depends upon the unlimited might and wisdom of God. Hence predestination is a divine necessity.

This view of predestination was presented more philosophically and clearly by Calvin in his catechism published at Geneva (1545). And it was this treatise, without a doubt, that, a century later, furnished the Westminster divines the foundation outlines for the Standards which they drew up in England's great Abbey of Westminster during the years 1643–8. The three products of that representative body called by the English parliament and made up of the most eloquent, pious, and scholarly divines, lords, commoners, and commissioners from every county of England and the universities of Oxford and Cambridge, are the Westminster Shorter and Larger Catechisms and the Westminster Confession of Faith.

In each one of these the doctrine of predestination is set forth, but more especially so in the third and tenth chapters of the Confession of Faith, which respectively treat "Of God's Eternal Decree" and "Of Effectual Calling." The paragraphs in these chapters that most pointedly outline the doctrine read as follows:

III. By the decree of God, for the manifestation of his glory, some men and angels are predestined unto everlasting life and others foreordained to everlasting death.

IV. Those angels and men, thus predestined and fore-ordained, are particularly and unchangeably designed; and their number is so certain and definite that it cannot be either increased or diminished.

As early as in the year 1831 the General Assembly of the Presbyterian Church was confronted with the demand for more liberty in the interpretation of the Creed of the Fathers. The marshaling of the forces who stood for a change in the form of statement, involving the doctrines of election and predestination, continued, as shown by the famous heresy trials of Drs. Barnes, Swing, Smith, and Briggs. After their deposition from the Presbyterian fold, the consideration of a revision of its Standards became a matter of serious importance. In view of this the General Assembly of 1889 resolved to transmit an overture to the presbyteries, asking them to consider the propriety of a revision of the Confession of Faith. The result of this action brought about the sentiment in favor of a revision. The Assembly of 1891 now asked the presbyteries for more suggestions. Again the answer came by a large majority of Presbyterial votes for a revision.

In 1893 the assembly was importuned once more for a new and shorter creed, but it voted to lay the matter aside. The battle of the theological giants did not cease at this. Again they pressed to the front. In consequence, the General Assembly of 1900 appointed a large committee to reconsider the matter of revision. After seven months they reported that "the returns indicated plainly that no change is desired which would in any way impair the integrity of the system of doctrine contained in the

Confession of Faith.» In spite of this negating motion, the General Assembly of 1902–3 added the Declaratory Statement to chapters III. and X., which reads as follows:

«With reference to chapter III. of the Confession of Faith: that concerning those who are saved in Christ, the doctrine of God's eternal decree is held in harmony with the doctrine of his love to all mankind, his gift of his Son to be the propitiation for the sins of the whole world, and his readiness to bestow his saving grace on all who seek it. That concerning those who perish, the doctrine of God's eternal decree is held in harmony with the doctrine that God desires not the death of any sinner, but has provided in Christ a salvation sufficient for all, adapted to all, and freely offered in the Gospel to all; that men are fully responsible for their treatment of God's gracious offer; that his decree hinders no man from accepting that offer; and that no man is condemned except on the ground of his sin.»

W. Francis Berger,
Presbyterian Clergyman.

Pred'icables, a term of the Aristotelian system of logic, denoting a class of concepts which may be predicated affirmatively of several others; it is now obsolete. The predicables are five in number, namely, *genus, species, differentia, proprium* and *accidens,* and were used in classifying objects on a systematic plan. Every object was conceived of as belonging to some species and that to some genus; objects in the same genus — a dog and a wolf, for example, would belong to different species because of the *differentia* between their characters — the specific *differentia;* a property (*proprium*) would form a ground of difference between members of the same species, *proprium* expressing, not an ultimate distinction, but one resulting from some other character, for example, the peculiarity of the shepherd dog, which is founded in the dog's natural sagacity; *accidens* is something not inherent in the nature of the object, but incidentally present in it, for example, the high value of the diamond.

Prefect, or **Préfet,** in European countries the name given a governor or civil commander, specifically, a title given to several officers, military, naval, and civil, in ancient Rome. Thus, in the times of the kings the officer appointed by the king to act as his deputy when he was compelled to leave the city was called the prefect of the city. Later, during the earlier ages of the republic, when both consuls were required for military service, a *præfectus urbi* was named by the Senate to act during their absence. He must have held the office of consul, and he enjoyed during the period of his office the same powers and privileges within the walls as the consuls themselves. In times of dearth or famine a commissioner was appointed to procure supplies, his official title being prefect of corn. In war the whole body of the cavalry was under the command of an officer, also styled a prefect. Under Constantine the prefects became governors of provinces. In France a préfet is the civil governor of a department, having control of the police and extensive powers in regard to municipal administration.

Preforma'tion, a theoretical view of embryological development widely held in the 17th century, and especially advocated by Haller. It asserted that the germ held in infinitesimal proportions all the parts and organs of the being, which were simply unfolded by growth. Hence this theory came to be known in England as the «evolution» theory and in French literature as the *emboîtement* theory. One class of thinkers regarded the egg as containing the whole of the embryonic material; another class thought it all contained in the spermatozoon. This whole baseless fabric of philosophy was overthrown by the microscopical researches of Wolf and the other founders of the science of embryology (q.v.).

Prehn'ite, or **Edelite,** a mineral, allied to zeolites and usually found with them, pale-green with a vitreous luster, crystallizing in the orthorhombic system. It is a hydrous silicate of aluminum and calcium, having the formula $H_2Ca_2Al_2Si_3O_{12}$. It is most frequently found in rocks of the basaltic type and is obtained from a wide area, being found in the copper region of Lake Superior, at Paterson and Bergen Hill, N. J., in Scotland, France, China, and South Africa. It was first found by Colonel Prehn in the 18th century at the Cape of Good Hope. It is cut into gems and slabs, resembling chrysoprase in appearance.

Prel'ate, a term used generally of bishops and archbishops of the Anglican communion, but bearing a more precise and specific meaning in the Roman Catholic Church, where it is applied to secular or regular clergy who have a jurisdiction inherent in their office, and not merely delegated by a superior. The title is especially used of the prelates of the pope's court and household who hold higher rank than other prelates.

Prell, prĕl, **Hermann,** German painter: b. Leipsic 1854. He studied at Dresden and Berlin under Grosse and Gussow respectively, supplementing this by a course of study in fresco painting in Italy. Returning home he was commissioned to paint the frescoes in the banquet hall of the House of Architects, in Berlin, and for this hall he executed a series of 11 paintings on the 'Main Epochs of the History of Architecture.' His other mural paintings are to be found in the City Hall of Worms ('Justice,' 'Valor,' and 'Henry IV. Granting Privileges to Worms in 1074'); the City Hall of Hildesheim; City Hall of Dantzic; the Breslau Museum; and the Albertinum, Dresden. The Dresden Gallery and the Breslau Museum contain specimens of his easel pictures. He has taught in the academies of Berlin and Dresden.

Preller, prĕl'lĕr, **Friedrich,** German painter, son of the following: b. Weimar 1 Sept. 1839; d. 1901. After studying under his father he followed the same departments in art, and his wall-paintings in the new theatre at Weimar (especially his 'Prometheus' and 'Iphigeneia'); and in the Albertinum at Dresden ('Olympia'; 'Pergamus'; 'The Acropolis at Athens'; and 'Ægina') have been much admired. He also produced a series of landscapes — scenes from Italy and Greece, in oil. His 'View of the Monastery of Santa Scholastica' is in the Dresden Gallery. He was professor in the Art Academy at Dresden.

Preller, Friedrich Johann Christian Ernst, German painter: b. Eisenach 25 April 1804; d. Weimar 23 April 1878. He became acquainted with Goethe in his youth, and received encouragement and finally a pension from the 'Duke of Weimar which enabled him to travel and study in Italy where he imbibed more from the classic than the Renaissance art and formulated a pictorial philosophy in which he saw man as the culmination of all earthly beauties. His important works, especially the series suggested by Homer's Odyssey, now in the Museum of Weimar, are bold and vigorous landscapes forming a setting for nude figures of heroic mold. To paint such subjects was the necessity of his artistic creed; yet he was obliged from poverty to turn at times to other fields. In 1840 he made a sketching trip to Norway, and frankly adopting the naturalism of Ruysdael he painted landscapes for sale. Even these were vigorous and meritorious in execution, if not fully representing his genius. He made unremitting sketches from nature and left behind him a long series of remarkable drawings. Consult: Roquette, 'Friedrich Preller' (1883); Muther, 'History of Modern Painting' (1896).

Pre'lude, in music, a short introductory strain preceding the principal movement, performed on the same key as it, and intended to prepare the ear for the piece that is to follow. It may consist of a series of unconnected chords when the intention is simply to attract the attention of an audience, or to fill a singer's ear with the key in which the piece is written, in which case it is generally improvised. It is, however, usually composed of part of the leading theme, more or less varied toward the close, and is not left to the invention of individual performers. See MUSIC.

Prelude, The, OR GROWTH OF A POET'S MIND, a poem by William Wordsworth (q.v.), summing up his philosophy of life and poetry, and hence «autobiographical.» It was written in 1799–1805, and was intended as an introduction to the 'Recluse,' of which only the 'Excursion' and some fragments were completed. The poem is addressed to S. T. Coleridge, and is a strange and typical admixture of Wordsworth's noblest and his more commonplace and dull.

Premonstraten'sians, or **Norbertines,** a religious order, founded by Norbert, canon of Xanten in Cleves, who on account of his zeal as archbishop of Magdeburg in 1127 was canonized. In the forest of Coucy, in a meadow pointed out to him, as he said, by Heaven (*prémontré, pratum monstratum;* thence the name of the order), he collected his first disciples (1120). Their order increased rapidly; several nunneries were established with the same rigid rules. The abbot of the original monastery Prémontré, near Coucy, was general, and with three other abbots formed the great council of the fathers of the order. The order was introduced into England in 1146, and its members were there regularly known as the White Canons. Before the Reformation they had 2,000 monasteries, among which were 500 nunneries, mostly in Germany, the Netherlands, France, England, and the north of Europe; but the Reformation diminished this number by more than one half in the 16th century. The monasteries in Spain attempted to revive their discipline in 1573 by uniting in a strict observance of their rules, but they remained in communion with those of the common observance. In 1630 this communion of all the monasteries of both kinds was confirmed by new statutes. In the 18th century the order had no houses in Italy; in France it had 42 monasteries; the nunneries had all disappeared. It now consists of a few houses in Poland and Austria, especially Bohemia, with some recently founded elsewhere, as at Crowle and Spalding in Lincolnshire, and Storrington in Sussex. In the United States the Provincial house of the Premonstratensians was founded at De Pere, Wis., by fathers from the abbey of Heeswijk, Holland. The Very Rev. Bernard Pennings, *O. Præm.,* Prior. The Fathers conduct missions in the archdiocese of Chicago, the dioceses of Green Bay, Grand Rapids, and in Canada. Fathers, 12; scholastics, 2; brothers, 4.

Prence, prĕns, or **Prince, Thomas,** American colonist: b. Lechdale, Gloucestershire, about 1600; d. Plymouth, Mass., 29 March 1673. He was one of the Leyden band of Pilgrims which settled in Plymouth in 1621 and his wealth soon gained for him considerable influence. In 1634 and in 1638 he was elected governor and was one of the assistants in 1635–7 and in 1639–56. He assisted in the settlement of Nansett or Eastham and from 1657 until his death was governor of Plymouth, the law requiring the residence of the governor in Plymouth being waived in his favor. He was zealous in the religious affairs of the colony, an active promoter of educational matters, and was the real founder of the public schools in New England. Consult Baylies, 'An Historical Memoir of the Colony of New Plymouth' (1866).

Prentice, prĕn'tĭs, **George Denison,** American journalist: b. Preston, Conn., 18 Dec. 1802; d. Louisville, Ky., 22 Jan. 1870. He was graduated from Brown University in 1823; studied law, but did not practise, and was editor of the 'New England Weekly Review' at Hartford, a literary journal, 1828–30. He then removed to Louisville, Ky., where in 1831 he became editor of the Louisville *Journal,* in which position he won widespread reputation for political ability, wit, and satire. For many years the *Journal* was a leading advocate in the West of the policy of the Whig party, and at the outbreak of the Civil War maintained with zeal the cause of the Union. A collection of his poems appeared in 1876 and a selection from his newspaper paragraphs under the title of 'Prenticeana' in 1860.

Prentiss, Benjamin Mayberry, American military officer: b. Belleville, Va. (now W. Va.), 23 Nov. 1819; d. Bethany, Mo., 8 Feb. 1901. He removed with his parents to Illinois in 1842, served in the Mexican War with rank of captain, and received honorable mention for services at Buena Vista. At the outbreak of the Civil War he reorganized his old company, was appointed colonel, and in May 1861 was made brigadier-general of volunteers. He routed a band of Confederates at Mount Zion, southern Missouri, in December 1861, joined Gen. Grant a few days before the battle of Shiloh and was taken prisoner in that battle, together with most of his command, while stubbornly holding the position to which he had been assigned. He was released a few months later, promoted major-general of volunteers, served as a member of the court-martial which tried Gen. Fitz-John Porter, and in July 1863 defeated the Confederate forces under Holmes and Price at St. Helena, Ark. He resigned his commission in

October 1863 and settled in Bethany, Mo., where he practised law.

Prentiss, Elizabeth Payson, American author: b. Portland, Maine, 26 Oct. 1818; d. Dorset, Vt., 13 Aug. 1878. She was married to George Lewis Prentiss (q.v.) in 1845 and after the death of two children turned her attention to literary work. Her most popular work, 'Stepping Heavenward' (1869), reached a sale of over 150,000 in this country besides being translated into French, German, Norwegian, and Italian, where it met with great success. Among her other works are: 'The Susy Books' (1853-6); 'Fred, Maria, and Me' (1867); 'Pemaquid' (1877); 'Gentleman Jim' (1878); etc. Consult G. L. Prentiss, 'Life and Letters of Elizabeth Prentiss' (1882).

Prentiss, George Lewis, American Presbyterian clergyman: b. Gorham, Maine, 12 May 1816; d. 1903. He was graduated from Bowdoin College, Brunswick, Maine, in 1835, studied theology in the universities of Halle and Berlin in 1839-41, and was ordained to the ministry in 1845. He was pastor of the South Trinitarian Church, Boston, 1845-51, of the Mercer Street Presbyterian Church, New York, 1851-8, when ill health compelled his resignation. In 1862 he established in New York the Church of the Covenant, and was its pastor until 1873 when he accepted the chair of pastoral theology, church polity, and mission work at Union Theological Seminary. He published: 'A Discourse in Memory of Thomas Harvey Skinner' (1871); 'Life and Letters of Elizabeth Prentiss' (1882); 'The Union Theological Seminary in New York, Historical and Biographical Sketches of Its First Fifty Years' (1889); etc.

Prentiss, Sergeant Smith, American orator, brother of G. L. Prentiss (q.v.): b. Portland, Maine, 30 Sept. 1808; d. Natchez, Miss., 1 July 1850. He was graduated from Bowdoin College, Brunswick, Maine, in 1826, removed to Natchez, studied law, and in 1829 was admitted to the bar after which he established a law practice in Vicksburg, Miss., and rapidly gained high rank in his profession. In 1835 he was elected to the Mississippi legislature, where he won a reputation as an orator and in 1837 he was elected to Congress, but upon arriving at Washington to take his seat found it occupied by the Democratic candidate, Col. Claiborne. In a speech of great brilliancy and power, which continued for three days, he argued his case before the House, attracting the attention of the country to the «Mississippi Election Case.» The controlling vote was cast by the speaker, James K. Polk, and Prentiss was defeated, but at the polls in the election following was triumphantly elected. His speech against the subtreasury bill sustained his reputation as an orator, but at the close of his term he declined reelection. In the campaign of 1840 he actively supported Gen. Harrison and in 1845 he strenuously opposed repudiation. He spent the last years of his life in practice in New Orleans, La. Consult G. L. Prentiss, 'Memoir of S. S. Prentiss' (1855).

Prenzlau, prĕnts'low, **or Prenzlow,** Germany, town in the province of Brandenburg, in Prussia; on the Ucker and Lake Ucker, 57 miles north by east of Berlin. It is divided by the river into an old and a new town, is well built, and has among its buildings a handsome Gothic church (erected 1325-40), a war monument, and a gymnasium. It has a number of manufacturing establishments, machine shops, woolen mills, tanneries, sugar works, etc. In 1806 a Prussian corps under Prince Hohenlohe surrendered here after the battle of Jena. Pop. about 22,000.

Preposition. See GRAMMAR.

Prerog'ative, in British history, a term used to denote an exclusive privilege of the Crown, the expression the prerogative being employed for the whole or any part of such exclusive privilege. The prerogative may be confined or limited by the supreme legislative authority, and has in fact been much restricted, notably by Magna Charta (1215), the Habeas Corpus Act (1679), and the Bill of Rights (1688).

Presbyo'pia. See SIGHT, DEFECTS OF.

Pres'byter. See BISHOP; PRESBYTERIANS; etc.

Presbyterian Church in the United States of America. The history of Presbyterianism in the United States is closely interwoven with that of the country at large. The early colonists were, for the most part, those who had crossed the ocean to find a home in the New World, in order to enjoy religious freedom. They came for conscience's sake, rather than for the advancement of their fortunes. They claimed the right to worship God according to the dictates of their own consciences, and to govern themselves in the administration of church order and discipline. They were bitterly opposed to the claims of prelacy. Alike among the Congregationalists of New England, the Dutch of New York, the Scotch-Irish of Pennsylvania, and the Huguenots of the Carolinas, the Calvinistic or Reformed system of doctrine was the prevailing belief. The Shorter Catechism of the Westminster Assembly, embodied in the New England Primer, had a more profound influence in the training of successive generations, than any other book of that period, except the Bible. It was the working creed of the men who laid the foundations of free institutions in America. The organization of the church among the colonists was determined largely by their previous associations in the Old World. The New England colonists were mostly of English-Puritan extraction, and favored the Congregational polity. There were, however, two parties among them; one zealously favoring Independency, the other leaning toward the Presbyterian polity. The former belonged to the school called Brownists, the latter to Barrowism. A strictly Presbyterian colony was established in Salem, Massachusetts Bay, under Roger Conant in 1625. Among those who held to Presbyterian views was Rev. Richard Denton, who came from England in 1630, and settled in Watertown, Mass. Driven out by opposition to his views, he removed in 1644, with some of his congregation, to Hempstead, Long Island, where a church was organized in accordance with the Presbyterian form. The earliest organization of Presbyterianism in the New World was made in the Dutch settlement of New Amsterdam, in New York, in 1628. It was a Reformed Dutch church, and the first Protestant church in America. Other churches of this denomination were organized at an early date among the Dutch settlements. (See REFORMED DUTCH CHURCH.) While the Presbyterian element was found in all of the colonies from New England to Georgia, circumstances prevented its separate organization. In New England the prevailing form of government was Independency or Congregational; in New York Presbyterianism was of the Dutch type, and only Episcopacy was allowed among the English. In Virginia, Episcopacy was established by law, and was intolerant toward all forms of dissent. Conditions were more favorable to Presbyterianism in the provinces of Pennsylvania, New Jersey, Delaware, and Maryland. To these colonies came a large number of emigrants from the North of Ireland, and from Scotland. The religious intolerance prevailing under the reign of Charles II. led them to seek refuge from it in the New World. It was among these emigrants that Presbyterianism took its organized form. In answer to a request from one of the scattered groups of Presbyterians, the Presbytery of Laggan, Ireland, sent as its missionary, Rev. Francis Makamie, in 1683. He journeyed in his missionary work as far south as the Georgias, and as far north as New York. He finally settled in Rehoboth, in eastern Maryland, where he organized the churches of Rehoboth and Snow Hill. In 1704 he returned to London, seeking aid for his work, returning in 1705, and bringing with him two additional ministers.

There was also, before the opening of the 18th century, a Presbyterian church in Philadelphia. Rev. Jedediah Andrews was its pastor, in 1701. In 1705 seven ministers, Makamie, Davis, Wilson, Andrews, Taylor, MacMish and Hampton, met by appointment in the city of Philadelphia and organized a Presbytery. It was the first Presbytery in America, and the beginning of the American Presbyterian Church in its organized form. The original minutes of this Presbytery are in the archives of the Presbyterian Historical Society in Philadelphia. This Presbytery was subsequently divided into three, which were included in a Synod. The Synod held its first meeting 17 Sept. 1717, in Philadelphia. In 1741 a division occurred in the Synod resulting, not from doctrinal differences, but from those ecclesiastical passions and unregulated zeal which have so often disturbed the church. One party under the leadership of the Tenents, father and son, and greatly helped by the ministry of the renowned evangelist, Whitfield, was earnestly solicitous for a revival in the church, charging it with formalism and worldly conformity. The other party, the conservative, resisted the charge, and sought to restrain by ecclesiastical action what they considered the immoderate zeal of the revivalists. The parties were known respectively as the New Side and the Old Side. The result of these controversies was the establishment of two independent synods, the Synod of New York, composed mainly of those favoring the New Side, and the Synod of Philadelphia, favoring the Old Side. Both synods unanimously affirmed their adherence to the Westminster Standards. This division lasted 17 years, and was healed by the reunion of the two synods in 1758, under the name of the Synod of New York and Philadelphia. With the reunion came renewed effort and enlarged prosperity. Churches were organized in the Carolinas, Georgia, Kentucky, Tennessee, Virginia and Western Pennsylvania. This enlargement of the Presbyterian Church had an important bearing on the subsequent efforts of the colonies to secure their independence. The Presbyterians everywhere were foremost in resisting civil and religious oppression, and when the period of the Revolution came, were unanimously in favor of independence, and the establishment of a government on republican principles. Thirteen months before the signing of the Declaration of Independence, in Philadelphia, the Presbyterians of Mecklenburg County, North Carolina, had drawn up and signed a Declaration of Independence from England, and also framed a system of local government. The Scotch-Irish Presbyterians in Western Pennsylvania declared for independence in May 1776. The Presbyterian element was everywhere a determining factor in the War of Independence.

In England, the rebellion was attributed especially to the Presbyterians. Walpole said in the English Parliament, "Cousin America has run off with a Presbyterian parson." At the close of the Revolutionary War, the Synod of New York and Philadelphia met, May 1788, and revised the Confession of Faith and the Form of Government in some minor matters, which were required by the change of allegiance in civil affairs. At the same meeting it was resolved to create a General Assembly, in which all the presbyteries should be represented by their commissioners. This General Assembly held its first meeting in the Second Presbyterian Church of Philadelphia, Thursday, May 1789. At this time the church had 16 presbyteries, 4 synods, 177 ministers and 431 churches. Among the first acts of the General Assembly was one directing that efforts should be made to send missionaries to the frontier. Before the close of the century, numerous churches had been established in the West and South. To prevent collision with the missionaries who went out from the Congregationalists in New England, the General Assembly, in 1802, entered into the Plan of Union with the associated churches of Connecticut, providing for the orderly organization of churches in mission fields. This Plan of Union continued in force until 1836, when it was abrogated by the General Assembly. It provided, in brief, that Congregational churches might settle Presbyterian ministers, and the reverse; and that if a congregation was composed partly of Congregationalists, and partly of Presbyterians, this fact should be no obstacle to their uniting in one church, and settling a minister; and that such a church, though not presbyterially organized, should have a representative in Presbytery. Its operation led to most favorable results in the extension of the church. The opening of the 19th century was a time of widespread religious revivals. "The Great Awakening" began in Kentucky, and it was attended there with some manifestations which met the disapproval of the more conservative element in the Church. In view of the great demand for ministers, some were authorized to preach who had not received a regular classical and theological education. There were also a few who held that the Confession of Faith taught fatalism. This led to the withdrawal of the Cumberland Presbytery, from which has sprung a large and influential body of Presbyterians known as the Cumberland Presbyterian Church. This separation took place 1810. (See *Cumberland Presbyterian Church.*) The first quarter of the century was one of rapid growth for the Church. The tide of emigration poured westward, and new settlements and towns were founded. In all these, the missionaries of the Church found a hopeful and fruitful field for their labors. During this period, the Board of Home Missions was organized (1814). Theological Seminaries for the education of ministers were also established; Princeton (1812); Auburn (1820); Western Theological Seminary, Allegheny, Pa. (1826); Union Seminary, Virginia (1828); Columbia, South Carolina (1828); Lane (1834); Hanover, subsequently removed to New Albany, thence to Chicago, and now known as McCormick Theological Seminary (1829). In 1825 appeared the beginnings of a controversy which ultimately resulted in the disruption of the Church. Various causes led to the formation of two parties, known subsequently as the Old School and the New School. Chief among these causes was the spread of New Haven Theology, or Hopkinsianism, which was supposed to be contrary to the doctrine of the Confession of Faith. It was also charged that through the Plan of Union, Presbyterian order had been subverted, and that innovations in worship were permitted in certain parts of the Church. In 1836 Dr. Albert Barnes, who sympathized with the new theology, was tried for heresy before the General Assembly, and acquitted. The previous year, Dr. Lyman Beecher, professor in Lane Theological Seminary, had been tried for heresy by the Presbytery of Cincinnati, and ultimately acquitted. All these things produced intense excitement in the Church, and widened the breach between the conservatives and the liberals. The Assembly of 1837, which met in Philadelphia, in response to a memorial signed by a large number of ministers and elders representing the Old School party, dissolved the Plan of Union with the Congregational Church, and exscinded the synods of Western Reserve, Utica, Geneva and Genesee.

At the meeting of the Assembly in Philadelphia, 1838, the commissioners from the exscinded synods presented themselves and asked to be enrolled; this being denied them, they with their friends proceeded to organize the assembly, and withdrew to hold its sessions in the First Presbyterian Church of Philadelphia. With the Old School party remained 140 commissioners, while 136 gave their adhesion to the newly organized Assembly. Thus began the unhappy division which lasted 32 years. Both Assemblies had the same name, and claimed to be the General Assembly of the Presbyterian Church in the United States of America; both held to the same confession and form of government. Both Assemblies engaged zealously in the work of home and foreign missions, and in the establishment of institutions of learning. Both, also, were troubled by questions concerning slavery. As early as 1787, the Presbyterian Church had declared itself in favor of the education of the slaves, and for the adoption of such «prudent methods as would procure eventually the final abolition of slavery.» In 1815, the General Assembly adopted a strong anti-slavery document, in which it expressed regret for the existence of slavery in the United States, urged the duty of educating slaves, and expressed the hope for their speedy emancipation. It further declared the buying and selling of slaves to be «inconsistent with the spirit of the Gospel.» These views were more clearly and positively avowed in the New School General Assembly than in the Old School General Assembly. In 1858, in consequence of some decided action taken with reference to slavery and emancipation, six southern synods withdrew from the New School Assembly, and constituted themselves the «United Synod of the Presbyterian Church.» In 1864 this Synod united with the General Assembly of the Presbyterian Church in the Confederate States. The passage of the «Spring Resolutions» by the General Assembly (Old School) in 1861 led to the withdrawal from that Assembly of a number of synods, all of which were within the bounds of the Southern Confederacy. This resolution was directed against the rebellion in the South, and called upon all of the members of the Church to support the government in defense of the integrity of the Union. It was bitterly opposed by the commissioners from the synods in the South, and by a small number from the Northern States, on the ground that in passing it the Assembly transcended its prerogatives. The objectors urged that the Assembly had no right to define civil duties. The vote on the resolution stood 156 in the affirmative, and 66 in the negative. The action resulted in the withdrawal of the synods in the seceding States, and the subsequent formation of the Presbyterian Church in the Confederate States of America. In 1866 the General Assembly Old School and the General Assembly New School met at the same time in St. Louis, when steps were taken with reference to the reunion of the two bodies, by the appointment of committees to consider a plan of union. These negotiations terminated favorably, and the basis of reunion, which was the Confession of Faith, after being approved by the presbyteries, was ratified by the Assembly in 1869. In May 1870, the first General Assembly of the reunited Church met in Philadelphia. In 1837, the year preceding the disruption, the ministers numbered 2,140, the churches 2,865 and the membership 220,537. At the time of the reunion, there were 4,238 ministers, 4,526 churches and 446,561 members. Since the reunion, the progress of the Church has been marked and steadfast. Two notable trials threatened for a time to disturb its peace. The first was that of Rev. David Swing, 1874, for alleged heresy with reference to the divinity of Christ. This case was settled by the withdrawal of Dr. Swing from the Church. The second was the trial of Prof. Briggs of Union Theological Seminary, for his advocacy of those views of the «higher criticism» which it was claimed affected the fundamental doctrines of the Christian faith. This trial resulted in the condemnation of his views, his suspension from the ministry, and his subsequent withdrawal from the Church.

The minutes of the General Assembly for 1906 show that the Church has 31 synods, 225 presbyteries, 7,603 ministers, 273 licentiates and evangelists, and 8,185 churches which contributed in the year, for home missions, $1,226,114; and for foreign missions, $1,182,516. Its contributions for all purposes exceeded $19,000,000. This branch of the Presbyterian Church in

America is the largest numerically, and occupies a leading position among the churches of the land. It has been noted for its missionary labors, especially in foreign lands, its zeal for education, and its unshaken adherence to its doctrinal standards. For the prosecution of its work it has Boards of Home Missions, Foreign Missions, Education, Publication and Sabbath School work, Church Erection, Ministerial Relief, Freedmen, and Aid for Colleges and Academies. It has also in connection with it, numerous schools, colleges, universities and theological seminaries. The national churches of Mexico and Brazil, both Presbyterian, have been established largely through its instrumentality. It has synods in India and China, and its mission operations are carried on in all parts of the world.

The Cumberland Presbyterian Church.— The origin of this branch of the Presbyterian Church is to be found in the great religious revival which swept over Kentucky and Tennessee, at the beginning of the 19th century. The demand at that time for an additional number of ministers in that region, led the Presbytery of Cumberland, in connection with the General Assembly, to license and ordain a number of young men of the Presbyterian Church, who had not received the required classical and theological training, for the gospel ministry. This proceeding was contrary to the rules and traditions of the Church, and was strenuously opposed by those who stood for the old ecclesiastical order. The Synod of Kentucky refused to sanction the acts of the Presbytery, and this decision was finally confirmed in part by the General Assembly. There were also among those engaged in this controversy some divergencies in doctrinal belief, especially with reference to what were claimed to be the fatalistic teachings of the Confession of Faith. The result was the withdrawal of those who were dissatisfied, and the formation of an independent presbytery, called the Presbytery of Cumberland. Those who organized it recognized as their standard of doctrine the Confession of Faith of the Presbyterian Church, but made provision for those who objected that fatalism was taught in it. The growth of this Presbytery was rapid. In three years it grew into a synod, composed of three presbyteries, and numbering 60 churches.

Its first meeting was held October 5, 1813, when it proclaimed a summary of its doctrines. A year later it revised the Confession of Faith, to meet its views regarding the articles to which exception had been taken. These were, specially, the third chapter with reference to the decrees of God, and the article with reference to the salvation of infants. The new church, filled with the revival zeal of its origin, made rapid advances. In 1827 it established at Princeton, Ky., an institution of learning, with a view to securing educated men for the ministry. In 1829 the General Assembly of the Cumberland Church was organized, consisting of five synods. At that time the field occupied by the Church embraced eight States, in which there were 18 presbyteries.

Since the organization of the General Assembly, the growth of the Church has been rapid and permanent. Its synods extend from Pennsylvania to the Pacific, and now number 16. The larger portion of its membership is contained within the boundaries of the States of Alabama, Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri, Tennessee and Texas. For the prosecution of its work it has an Educational Society, Boards of Ministerial Relief, Home and Foreign Missions, Publication, Sunday Schools and Young Peoples Societies. It has under its supervision the following institutions of learning, Cumberland University at Lebanon, Tenn.; James Milliken University at Decatur, Ill., embracing Decatur College and Lincoln College at Lincoln, Ill.; Missouri Valley College at Marshall, Mo.; Trinity University, Texas, and Waynesburg College, Waynesburg, Pa. The Minutes of the General Assembly for 1905–6 show that it has a total membership of 195,770, 2,398 churches, 1,514 ordained ministers, church property to the value of $5,804,000; and that its total contributions for the year, for all purposes, were $1,000,000. During its history, various attempts have been made to restore its union with the Presbyterian Church in the United States of America, but they failed on account of doctrinal differences until 24 May 1906 when, in convention assembled, the former at Decatur, Ill., the latter at Des Moines, Ia., the reunion was accomplished.

The Colored Cumberland Presbyterian Church.— Prior to the Civil War, the number of colored people in connection with the Cumberland Church amounted to 20,000. In times of slavery, they worshipped in the same buildings with their masters, a particular portion of the church being assigned to them; but they were not allowed to participate in the government of the church. After the Civil War, it was deemed expedient that these members should be associated in a separate organization. Accordingly presbyteries and synods were formed, which met in a General Assembly, May 1, 1874. This organization, whose statistics are rather indefinite, now reports a membership of 18,000. It has one educational institution, but the poverty of the people has prevented them from obtaining a thoroughly educated ministry.

The Presbyterian Church in the United States (Southern).— This Church had its origin at the beginning of the Civil War, and from causes connected with it. The action of the General Assembly, Old School, in 1861 was one of the leading causes. By the passage of the «Spring Resolutions» concerning the Civil War, it had determined for all under its jurisdiction, that their allegiance was due to the national government. A minority held that this action, whether true or false, was beyond the jurisdiction of the General Assembly, and that in making it, the Church was transcending her sphere, and usurping the duties of the state, which alone had the power to define civil duties. A protest was presented against this action, in which it was urged that the Assembly in thus deciding a political question, and in making that decision binding upon those under its care, practically made a condition of church membership which violated the constitution of the Church, and usurped the prerogative of its divine Head. Presbyteries in the seceding States generally coincided with this view, and concluded that a separation from the General Assembly was demanded for the defense of a great truth, and for the protection of the liberty with which Christ had made them free. The organization of the Confederate States furnished another reason. It was, in brief, that the changed condition of civil affairs made it expedient and necessary that the presbyteries within the bounds of the Confederacy should be organized as a separate and independent body. Accordingly 93 ministers and elders, representatives from presbyteries, met in Augusta, Ga., December 4, 1861, and constituted a General Assembly, under the name of the General Assembly of the Confederate States of America. They adopted at the same time, as their standards of doctrine, the Westminster Confession of Faith, and the Form of Government as held in the old church. At the close of the war, the name of the church was changed to the Presbyterian Church in the United States. In 1864 the United Synod of the South, composed of the presbyteries and churches which had seceded from the General Assembly (New School), on account of its action concerning slavery, was admitted into the General Assembly of the Confederate States. It consisted of 120 ministers, 190 churches and 12,000 communicants. In 1869 that portion of the synod of Kentucky which had separated from the General Assembly (Old School) in 1867, was received into connection with the Southern General Assembly, bringing with it 13,540 communicants. In 1874 the independent Synod of Missouri, which had separated itself from the Northern Assembly on account of its action concerning civil affairs, united with the Southern Assembly. The churches in connection with this Assembly are almost exclusively in what is known as the Southern States, and for that reason it is commonly called "the Southern General Assembly" in distinction from the Assembly, North. Its missionary and benevolent operations are not conducted by organized boards, but through committees elected annually by the General Assembly, directly responsible to it, and acting under its instruction. It carries on mission work in China, Africa, South America, Greece, Italy and Mexico. Its home mission work is conducted with vigor and efficiency, and includes work among Indians and Negroes, as well as the white population. It has under its care, Union Theological Seminary at Richmond, Va.; the Theological Seminary at Columbia, S. C., and the Theological Seminary at Louisville, Ky. The last named institution, having been joined with Danville Seminary, is now under the joint control of both synods of Kentucky, one in connection with the Northern and the other with the Southern Assembly. This branch of the Church, while holding in common with other Presbyterian Churches, the Westminster Confession and Catechisms, Larger and Shorter, lays special emphasis upon the spirituality of the Church in its functions. It insists that church courts shall be governed by the article of the Confession which says, "synods and councils are to handle or conclude nothing but that which is ecclesiastical." Statistics for this Church in the year 1906 are as follows: Ministers 1,606, churches 2,722, communicants 266,345, Sunday School scholars 189,767, total contributions $2,500,000.

The United Presbyterian Church of North America.— This organization is the result of a union between the Synod of the Associate Reformed Church, and the Associate Synod, commonly known as the Seceders. This union took place in Pittsburg May 26, 1858. The basis of it was the Westminster Confession of Faith, with a modification of the chapter on the power of the civil magistrate, the Catechisms, Larger and Shorter, and a Judicial Testimony. Most of the articles in this testimony are held in common by all Evangelical churches, but there are five which are special to this denomination. The first declares that slave holding is a violation of the law of God, and contrary both to the letter and spirit of Christianity. The second declares that all secret and oath-bound societies are inconsistent with the genius and spirit of Christianity, and that church members ought not to have fellowship with such associations. The third is a declaration in favor of close communion; none are to be admitted to the sealing ordinances of the Church except such as give their assent to its doctrines. The fourth declares the duty of public social covenanting at special times. The fifth affirms that it is the will of God that the songs contained in the Book of Psalms should be used exclusively in public worship, and that hymns, the composition of uninspired men, should not be employed in such service. In all other respects, the laws, government, and discipline of this church are the same as those of other branches of the Presbyterian Church. It has been distinguished for the careful training of its ministry. It has in its connection two theological seminaries and six colleges. For the execution of its work the United Presbyterian Church has seven Boards, namely, Home, Foreign, Freedmen's Mission, Church Erection, Publication, Education, and Ministerial Relief. Its Foreign Mission work has been extensively carried on in Trinidad, Syria, India, Egypt, and China.

The Reformed Church in the United States (German Reformed).—Previous to the Revolutionary War, a considerable number of emigrants from the Palatinate, a district of Germany, emigrated to America and settled in Pennsylvania. They were members of the Reformed Church in Germany, and were men of sterling character and devoted piety. They became important factors in the settlement of Middle and Western Pennsylvania, and also took part in the Revolutionary War. The first German Reformed minister settled among these emigrants was Philip Boehm, who came to America in 1720. In 1747 there were five ordained ministers and 46 organized churches. In 1793, at which time the synod was divided into classes, there were 22 ordained ministers and about 150 churches. Subsequently affiliated synods were organized in Ohio, and in the neighboring States; but it was not until the year 1863 that organic union was established between them. The General Synod was organized November 18, 1863, in Pittsburg, Pa. It holds its sessions triennially. It is a delegated body composed of an equal number of ministers and elders, elected by the several classes; constituting eight synods. The General Synod has under its control the various boards to which are entrusted the work of home and foreign missions, and also that of the Sunday school. The membership of the church is located in the northern belt of the country extending from the New England States to the Pacific slope, and southward as far as North Carolina.

The Reformed Presbyterian Church in North

America.— This organization traces its ancestry to the Covenanters, and claims to be a lineal descendant of the Kirk of Scotland. Its name has a twofold significance, and is a resumé of its history. It is called Reformed, to indicate that it was founded on the principles of the Reformation, and Presbyterian, because of its adoption of and long struggle to maintain that form of government. The first presbytery of the Reformed Presbyterian Church in America was organized in 1774. In 1782 the majority of this presbytery united with the Associate presbyteries, and formed the Associate Reformed Church. A few refused to accept the union, and maintained their organization in what was called «praying circles.» Ministers having been obtained from Scotland, in 1798 the presbytery was again constituted. In 1809 the Synod of the Reformed Church was organized with three presbyteries, in Philadelphia; through the increase of churches and presbyteries, a General Synod was in time organized. But in 1833 a division occurred by which it was separated into two branches, known respectively as the Synod of the Reformed Church, and the General Synod of the Reformed Church. The distinctive features of the Reformed Church are, first, the Kingly office of Christ in the sense that nations as well as individuals are his subjects, and should acknowledge his authority. Hence Reformed Presbyterians «decline to hold office or to exercise the right of suffrage in any government that does not clearly own Christ as king and his law as supreme.» Second, the exclusive use of the Psalms in praise. Third, opposition to secret and oath-bound societies. Fourth, communion restricted to church membership. The cause of the division of the synod into two branches was a difference of opinion concerning the application of these distinctive principles, one party demanding a rigid, and the other a liberal interpretation. The synod of the Reformed Church, representing the «Old Side,» is the stronger of the two branches. It has now 112 congregations, 1,127 ministers, 9,304 communicants and 12 presbyteries. The General Synod has a membership of 4,500.

The Christian Reformed Church.— The organization of this church took place in 1857. It is lineally descended from the Reformed Church of Holland. About the year 1847 a large number of Hollanders, connected with the Christian Reformed Church of the Netherlands, emigrated to America and settled in Michigan. For a short time they became associated with the Dutch Reformed Church, now the Reformed Church of America; but after a time withdrew on account of what they deemed laxity in doctrine and discipline, and formed an organization of their own. Its membership is to be found mainly in the States of Michigan, Illinois, Iowa and New Jersey, with a few scattered congregations in New York, Ohio, Indiana, Wisconsin and Minnesota. It is rigidly Calvinistic in its doctrines, accepting as its standard the articles of the Synod of Dort, and the Heidelberg Catechism. It is opposed to secret oath-bound societies, and use almost exclusively the Psalms in the service of praise. It uses also a liturgy in the administration of the sacraments, and in the ordination of ministers and elders. Its theological school is in Grand Rapids, Mich. At present it numbers about 160 churches, 110 ministers, 9 presbyteries and over 13,000 communicants. Its General Synod meets biennially, at Grand Rapids, Mich. Its ministers officiate in the English, German, French, Bohemian and Hungarian languages.

The Welsh Calvinistic Methodist.— This branch of the Presbyterian body is derived from the Calvinistic Methodist Church of Wales. The first church of this denomination in the United States was organized in Remsen, N. Y., and three years later the first presbytery was constituted. On Sept. 22, 1869, the General Assembly was organized and held its sessions in Columbus, Ohio; and it has met triennially ever since. Its standards of doctrine are the same as those of the parent church in Wales. Its system of government is presbyterian. It has now 6 synods, 162 churches, 88 ministers and 12,146 members. The church exists among the Welsh in 13 States of the Republic.

The Associate Reformed Synod of the South. — The origin of this synod dates back to the year 1821. It was the result of a secession from the Associate Reformed Church on account of differences concerning psalmody and communion questions. Its membership is confined principally to the Southern States, and numbers about 12,000. Its doctrinal symbols are the same as those of other Reformed churches.

There are also in the United States several organizations of Presbyterians known respectively as, The Associate Church of North America, The Reformed (Covenanted) and The Reformed in the United States and Canada. The number of their adherents is small, not exceeding 2,000.

Presbyterian Churches in Canada.— Presbyterianism in Canada is of Scottish origin, and in it are to be found representatives of every shade of Presbyterianism that has appeared in the British islands. Its early history is marked by divisions, which in course of time have been overcome. In 1831 the Synod of the Presbyterian Church of Canada, in connection with the Church of Scotland, was organized. Meanwhile other Presbyterian ministers, chiefly of the Associate Church of Scotland, organized themselves as the United Synod of Upper Canada. These two bodies were united in 1840. Previous to this union another church had been formed under the name of the United Presbyterian Church in Canada. On 10 July 1844, 25 ministers, in connection with the Church of Scotland, who were in sympathy with the Free Church movement in Scotland, withdrew from the synod, and constituted themselves a separate body, under the name of the Presbyterian Church of Canada. For 17 years these three bodies maintained a separate existence; but in 1861 a union was effected between the United Presbyteries and the representatives of the Free Church, under the name of the Synod of the Canada Presbyterian Church. This synod entered upon a prosperous career, and in 1870 the Supreme Court of this church was for the first time constituted as a General Assembly. In 1866 a union was accomplished between the churches of Nova Scotia and New Brunswick; and in 1868 the synods of Nova Scotia and New Brunswick, in connection with the Church of Scotland, formed one synod. A general union of all the churches took place in the year 1875, into which union, under the name of the Presbyterian Church of Canada, came the Presbyterian Church in Canada, in connection with the Church of Scotland, the Canada Presbyterian Church, the Church of the Lower Provinces, and the Church of the Maritime Provinces in connection with the Church of Scotland. This union was cordial, and it has been followed by marked progress and substantial prosperity. The united Church is vigorously engaged in the work of home and foreign missions, and has five theological seminaries.

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Presbyterian System, Alliance of the Reformed Churches throughout the World holding the. Previous to 1870 the desire had been frequently expressed that the various branches of the Presbyterian Churches could be united in some general alliance which would express the generic unity of Presbyterianism. Some attempts had been made in this direction, but the first official step in this country was taken by the General Assembly of the Presbyterian Church U. S. A. at its sessions in Baltimore 1873. As a result of this action, the Alliance was formed by representatives from different Presbyterian Churches in London, England, in the year 1875. The Alliance is composed of representatives from different branches of the Presbyterian Church throughout the world. The action of its General Council is not legally binding upon any of the Churches, but only advisory in its character. It has, however, been enabled through its counsels to regulate the mission work of the Church, and to bring different branches of the Presbyterian family into closer relations, for mutual support. The Alliance has held seven General Councils: the first was in Edinburgh, Scotland, 1877; the second in Philadelphia, U. S. A., 1880; the third, in Belfast, Ireland, 1884; the fourth in London, England, 1888; the fifth in Toronto, Canada, 1892; the sixth in Glasgow, Scotland, 1896; the seventh in Washington, D. C., 1899. The eighth Council will be held at Liverpool, England, in 1904. The churches connected with the Alliance number more than 90, and are located in all parts of the world. The adherents of the Presbyterian and Reformed Churches represented in the Alliance, number about 25,000,000. The following tables show the number of communicants in America and Great Britain, and the number of adherents in other countries:

IN THE UNITED STATES.

The Presbyterian Church in the U. S. A.	1,179,566
The Presbyterian Church in the U. S.	266,345
The United Presbyterian Church of N. A.	130,342
The Cumberland Presbyterian Church	195,770
The Reformed (Dutch) Church in America	116,174
Christian Reformed Church in N. A.	27,306
The Reformed (German) Church in the U. S.	293,836
Reformed Presbyterian Church, Synod	9,045
The Associate Reformed Synod of the South	13,201
Reformed Presbyterian Church, General Synod	3,620
The Welsh Calvinistic Methodist or Presbyterian Church in the U. S. A.	13,280
Other Churches	2,500
Total	2,250,985

IN CANADA.

The Presbyterian Church in Canada	219,570
Church of Scotland in Canada	10,000

IN ENGLAND AND WALES.

The Presbyterian Church of England	78,037
The Church of Scotland in England	3,800
Calvinistic Methodist or Presbyterian Church in Wales	160,000

IN IRELAND.

The Presbyterian Church in Ireland	106,053
The Reformed Presbyterian Church in Ireland	4,000
Other Churches	2,000

IN SCOTLAND.

The Church of Scotland	668,335
The United Free Church of Scotland	495,259
Other Churches	5,000

EUROPE.

Bohemia	70,000
France	800,000
Germany	3,000,000
Holland	2,500,000
Hungary	2,000,000
Switzerland	1,700,000
Other Countries	500,000

MISCELLANEOUS.

Africa	400,000
Asia	400,000
Australasia	700,000
South America	60,000

Consult: 'Minutes of the Presbyterian Alliance' (1877–99).

SAMUEL J. NICCOLLS, D.D.,
Ex-Moderator, Presbyterian Assembly.

Presbyterianism, a term derived from the Greek word πρεσβύτερος, meaning "an elder," defines, primarily, a system of church government. As such, it stands midway between Episcopacy or Prelacy, and Independency or Congregationalism. It affirms that the Church, as to its government, is a theocracy under law to Christ, its supreme and only Head and Lawgiver; but the powers of government are vested in the body of believers, and are to be exercised through their chosen representatives called "elders." It denies the claim of one man, or of a special class of men, to rule the Church by virtue of a divine right. In opposition to papacy and prelacy, it asserts the right of the Church to govern itself through its chosen representatives, administering rule and discipline according to the word of God. "The radical principles of Presbyterian Church government and discipline are: that the several different congregations of believers, taken collectively, constitute one church of Christ, called emphatically, The Church;— that a larger part of the church or a representation of it, should govern a smaller, or determine matters of controversy which arise therein; that in like manner a representation of the whole should govern and determine in regard to every part, and to all the parts united; that is, that a majority shall govern; and, consequently, that appeals may be carried from lower to higher judiciaries, till they be finally decided by the collected wisdom and united voice of the whole church. For these principles and this procedure, the example of the Apostles and the practice of the primitive Church are considered as authority.»

The Presbyterian form of government is essentially republican. It differs from Congregationalism in that it asserts the visible organic unity of the Church in the sense that all local or individual churches are included under one government, in which the majority governs. In accordance with its representative form of government, it has a succession of church courts or judicatories. First in order is the session, or consistory, of the local church, chosen by its members. Next is the presbytery, having jurisdiction over the ministers and churches within a certain limited district. It is composed of the ministers, and one elder from each church in the district. The synod, likewise a representative body, has jurisdiction over the presbyteries; and there must be at least three presbyteries to compose a synod. The boundaries of synods in America are usually, and for the sake of convenience, coterminous with the boundaries of the States in which they are located.

The highest court is called the General Assembly, or General Synod. It is a representative body, composed of an equal number of ministers and elders elected by the presbyteries. The number of representatives from each presbytery varies according to the membership of the presbytery; but each presbytery is entitled to be represented by one minister and one ruling elder. The General Assembly represents all the churches under its care. It exercises administrative, legislative and judicial powers, and its decisions are final and binding upon all the lower courts, when made in accordance with the constitution of the Church. Another characteristic of Presbyterianism is the parity or equality of the ministry. According to its teachings, there are but two permanent official orders in the Church, bishops or elders, and deacons. The first includes both teaching and ruling elders. The term deacon includes the two-fold distinction of male and female. The deacons are those to whom is especially committed the administration of the charities of the church (Acts vi. 3).

Presbyterians claim for their order and form of government, apostolic and scriptural sanction. Some among them have gone so far as to assert that the presbyterian form of government is *jus divinum,* and that none other can be allowed in the church. This extreme position, however, has had but very few advocates.

The general view is, that it is an ancient form of government having apostolic sanction, and that it is agreeable to Holy Scripture. The main argument by which this view is supported is in brief this: The office of elder was established in the Old Testament Church in the earliest time. The elders were a distinct class of office bearers in the Hebrew commonwealth, and ruled in the synagogue or local church. In biblical history they are mentioned as representatives of the people (Exodus iii. 16 and iv. 24; 1 Samuel viii. 4; 2 Samuel v. 3; 1 Kings viii. 1). They were especially prominent in the synagogue worship, familiar to the Jews from the time of the return from the Babylonian captivity. Each synagogue had a bench of elders, with a presiding officer known as the «chief ruler,» to which was entrusted the oversight of the congregation. The «rulers» of the synogague, mentioned in the gospel narrative, were these elders. The government of the synagogue, with its system of apellate courts terminating in the Sanhedrin, was presbyterian (Edersheim, 'Life of Christ,' Vol. II., p. 552). Jesus Christ and His chosen apostles, the founders of the Christian Church, had been trained in the synagogue and were accustomed to no other form of church government. They knew that it had been previously sanctioned by prophets, priests, and kings, all through the history of the chosen people. It was but natural that the same form of government should be adopted in the new church or «Ecclesia,» the body of those «called out» from the synagogue.

That the synagogue furnished the model for the government of the Christian Church, is confirmed by the statements of the Apostles. Acts xiv. 23 and xx. 17–18; 1 Peter v. 1; 1 Timothy iv. 14 and v. 17. It is further claimed that the terms *episcopos* and *presbyteros,* signifying respectively bishop, and elder, are equivalent terms designating the same office. Elders and deacons constituted the office bearers of the early Church. In course of time the «chief ruler» came to be known as *episcopos,* the bishop of the church; but each church had its own bishop or overseer. They were what the Presbyterian pastor is at the present time. Such in general are the grounds upon which Presbyterians claim that their form of government is both primitive, apostolic, and conformed to the New Testament Church order. Whatever may have been the primitive form of church government in the Christian Church, it is a historical fact that from the 3d century what is known as prelacy became the prevailing order, culminating in the papacy. At the time of the Reformation (1692–1700) all the Reformers desired to restore to the people their primitive rights, but there was considerable diversity of opinion as to methods. John Calvin, in Geneva, was the first to organize a representative government in a practical form, by restoring the eldership to the church.

His conception of the eldership was adopted in the Reformed churches of Scotland, France, Holland, and practically in Germany. It was through the struggle to maintain a representative form of government, as against the claims of prelacy, that the term «Presbyterian» was applied to the churches holding that form of government. The Church of Scotland and the Reformed churches of France and Holland are Presbyterian as to their form of government. Most of the Reformed churches have adopted, with slight modifications, the Presbyterian polity. The Methodist Episcopal Church in America, the largest of the Protestant bodies, while Episcopal in name, has become Presbyterian in fact, so far as polity is concerned. In the Protestant Episcopal Church there is now representation from the laity, and the powers of the presbyters have been greatly enlarged. The Lutheran Church in the United States is also Presbyterian in polity.

The Doctrines of the Presbyterian Church. — While the term «Presbyterian» defines, primarily, a polity or form of church government, it is also definitive of a system of doctrine, known as the Calvinistic or Reformed. So far as doctrine is concerned, Presbyterianism and Calvinism are synonymous. It is a popular mistake to suppose that Presbyterians accept all the teachings of the great Genevan reformer, John Calvin; but his statement of the Pauline or Augustinian system of theology is generally accepted by all branches of the Presbyterian family, and is embodied substantially in their Confessions. The five distinguishing features of the Calvinistic doctrine are: the absolute sovereignty of God in creation, providence, and redemption; the fall of man and his utter inability to save himself from the consequences of his transgression; the election from this fallen race by the sovereign grace of God of a certain number unto eternal life; the provision made for their salvation in Jesus Christ: their effectual calling by the Holy Spirit; and their perseverance in divine grace, assured by the indwelling of the Holy Spirit.

The accepted symbols of the Presbyterian faith are, the Canons of the Synod of Dort, 1619 A.D., the Westminster Confession of Faith with the Catechisms, Larger and Shorter, 1648 A.D., and the Heidelberg Catechism, 1563 A.D. (See DORT, SYNOD OF, and WESTMINSTER ASSEMBLY.) These symbols are regarded as subordinate standards. Presbyterians receive the Scriptures of the Old and New Testament as the supreme standard, «the only infallible rule of faith and practice.» In America, the most widely accepted symbol of faith is the Westminster Confession, slightly modified from its original form. In the year 1900 a movement was inaugurated in the largest denomination of the Presbyterian Church, for a revision of the Confession of Faith. This movement resulted in the adoption in the year 1903 of an explanatory statement with reference to the third chapter of the Confession of Faith, and in sundry minor amendments. The Assembly also adopted a Brief Statement of Doctrine to be used in the churches under its care. The Confession of Faith as revised still remains the authoritative standard of the church. Ministers and office bearers are required to subscribe to it in the following terms: «Do you sincerely receive and adopt the Confession of Faith of this Church as containing the system of doctrine taught in the Holy Scriptures?» But the only requirement for admission to the communion of the Presbyterian Church is faith in the Lord Jesus Christ, as the divine Saviour of men.

While claiming that their polity is lawful and agreeable to the Word of God, and that their system of doctrine is that taught in Holy Scripture, Presbyterians recognize all other churches holding to the essential doctrines of Christianity as parts of the one Catholic Church.

History of the Presbyterian Church.—The history of Presbyterianism begins with the reorganization of the church in the Reformation period, at a council held in Zürich 26 Oct. 1523, at which the principles of primitive Presbyterianism were formally adopted, and thereafter became the distinctive features of the Reformed Churches in Switzerland, France, Belgium, Holland, and Prussia. They were adopted by the Church of Scotland which, under the leadership of John Knox, separated herself from the papacy. They were also introduced into England about 1572 by Cartwright. In Scotland, and in the North of Ireland, Presbyterianism has continued to be the dominant faith; and from these great centres it has exerted an influence extending throughout the world.

The Church of Scotland.— Presbyterianism in Scotland is divided into different branches, chief of which is the Church of Scotland, commonly known as the Established Church. It is the state church, supported by the government.

It was organized in 1560 and legally established in 1592 by the Scottish Parliament. It is, numerically, the largest church in Scotland, and its various enterprises are carried on with great energy and liberality.

The Free Church of Scotland.—This branch of Presbyterianism originated in a separation from the Established Church in the year 1843. The immediate cause of the disruption was diversity of views on the subject of patronage. One of the principles of Presbyterian government is, that «no minister should be intruded upon a congregation contrary to its will.» By Act of Parliament, the right to appoint ministers to vacant churches had been conferred on certain landed proprietors connected with the parishes. The General Assembly for many years protested against this enactment, but to no avail. The exercise of this legal right in a particular case led ultimately to the withdrawal of a large number of ministers and churches from the establishment, and to the organization of the Free Church of Scotland. But the great underlying reason for this movement was, the determination to maintain the spiritual independence of the church from the civil power, and her liberty to obey the Lord Jesus Christ as the Supreme Head of the Church. The new organization grew rapidly and took a foremost place in missionary and educational work.

The United Presbyterian Church of Scotland. — This organization originated 13 May 1847 in a union between the United Secession and the Relief Churches. These churches had originated from doctrinal differences in the past, and the harsh exercise of discipline in the Establishment. The United Church has been distinguished for its missionary zeal and progressive spirit. It has been said of it, that it has done more for the diffusion of the gospel throughout the world than any other denomination of its size, except the Moravians. As early as 1862 negotiations for a union of this branch of the church with the Free Church were commenced, but without success until in the year 1900 the two bodies were united under the name of The United Free Church of Scotland.

Its first General Assembly met in Edinburgh, October 1901. The statistics for the United Free Church for 1902 are as follows: Membership, 495,259; Sunday School scholars, 244,339; Bible Class pupils, 89,889; contributions for all purposes, $5,250,000. There are in the church 11 synods, 64 presbyteries, and 1,800 ministers.

The Presbyterian Church of England.— Presbyterianism in England is associated with the great Puritan movement in that country. It manifested itself in the famous Westminster Assembly, 1643. When prelacy was abolished by the Long Parliament, Presbyterianism was established in its stead, 29 June 1647, and for 20 years it was the national church of England. But opposed by Cromwell and Independency, on the one side, and by the Episcopal Church on the other, it was destined to lose its position. After the restoration of Charles II., and on St. Bartholomew's Day, it was dis-established and 2,000 ministers, most of them Presbyterian, were ejected from their parishes. In 1686 Presbyterianism was, by act of parliament, denied civil and religious rights. The passing years brought some amelioration, as a more tolerant spirit pervaded legislation: but from that time until 1850 it had only a feeble existence. Since the latter date, through the union of various scattered churches, Presbyterianism has greatly revived in England. In 1876 these churches were gathered in one Synod and are known as the Presbyterian Church of England. Its membership numbers 79,000.

Welsh Calvinistic Methodist (*Presbyterian*). —This church represents Presbyterianism in Wales. The movement which resulted in the establishment of this church began in 1736. It has now a General Assembly, whose decisions are binding upon the churches in all matters of controversy between them. Its Confession of Faith in all essential articles is in harmony with the Westminster Confession, and with the Thirty-Nine Articles of the Church of England. Its leading Theological Seminary is at Bala, North Wales. It has also under its care a college at Trevecca, South Wales. It has both Home and Foreign Missionary Societies, and a fund for the support of aged and infirm ministers. The above named churches are the principal branches of the Presbyterian Church in the United Kingdom of Great Britain. In addition to these there are in Scotland the Reformed Presbyterian Church, and the original Secession Church of Scotland, with a combined membership of about 5,000; and in England a branch of the Church of Scotland.

The Irish Presbyterian Church.— Presbyterian ministers began their work in Ireland as early as 1594, but on account of persecution, Presbyterianism did not obtain a permanent footing there until 1642. It found its home in the northern part of the island, and in the Province of Ulster. Its progress was at first hindered by divisions, and by the presence of Arianism which was openly avowed by some of its ministers. In 1840, the various churches were united in one body under the name of the General Assembly of the Presbyterian Church in Ireland. Since this union the Irish Presbyterian Church has occupied a commanding position in the country. It has at present more than half a million people under its care, 560 congregations, over 600 ministers, 5 synods, and 37 presbyteries. For a time its ministers were supported by the *Regium Donum* — a grant from the state. About thirty-three years ago this grant was commuted into a general fund amounting to $3,000,000. This is the basis of the Sustentation Fund, the income from which, increased by voluntary contributions from the churches, supports the ministry. The church has large Foreign Missions, and has under its care the Assembly's College at Belfast, and the Magee College, Londonderry. For the last 150 years there has been a constant stream of emigration from the north of Ireland to America and the British colonies, so that the Irish Presbyterian Church has been largely instrumental in establishing Presbyterianism in other parts of the world.

Presbyterian Churches in Europe.— The Reformed churches of the Reformation period in Switzerland, France, Germany, Bohemia, and the Netherlands were generally Presbyterian as to their form of government. In addition to these is the ancient church of the Waldensians, dating from primitive times and now established in various parts of Italy and Switzerland. In later years the Presbyterian Church has been extended to Spain, Hungary, Austria, Russia, and Norway. The number of adherents in Europe is 10,320,000.

Bibliography.— For the Churches of Scotland: Histories of the Scottish Church by Calderwood, Spottiswoode, Row, Woodrow, Cook, Lee, Grub, Cunningham, and Stanley; Hill, 'View of the Church of Scotland'; Dunlop, 'Book of the Universal Kirk'; and 'Collection of Articles of Faith of Authority in the Church of Scotland.'

For the Churches of England: McCrie, 'Annals of English Presbytery'; Skeats, 'History of Free Churches in England'; Brook, 'Life of Thomas Cartwright'; Grosart, 'Representative Nonconformists.'

For the Churches of Ireland, and Continent of Europe: 'Records of a General Council of the Presbyterian Churches' (1877–99).

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Pres'bytery, in Presbyterian churches, a court of judicature consisting of all the ministers of the denomination within a given district, and of ruling elders, one from each church session. Each meeting is opened with prayer by the moderator. The functions of the court are purely executive, not legislative. It has supervision of all the congregations within its territorial limits, hears appeals from decisions of the several sessions, examines candidates for the ministry, issues licenses to probationers, ordains ministers, and in general guards the spiritual interests of the congregations under its charge in matters whether of doctrine or of discipline.

Prescott, prĕs'kŏt, **George Bartlett**, American electrician: b. Kingston, N. H., 16 Sept. 1830; d. New York 18 Jan. 1894. He studied electricity and telegraphy, and from 1847–58 was manager of several telegraph offices in Connecticut and Massachusetts, becoming in the latter year superintendent of the American Telegraph Company, and in 1866 accepted the same position with the Western Union Company. He was electrician of the International Ocean Telegraph Company in 1873–80, was actively interested in various telephone and telegraph companies, and was one of the promoters of the former. He discovered the electrical origin of aurora borealis in 1852, invented several improvements in telegraph and telephone instruments, was engaged with Edison in the invention of the duplex and the quadruplex telegraph which he successfully launched on the market, and introduced in this country the European system of despatching messages through pneumatic tubes. He published in the 'Boston Journal' and in the 'Atlantic Monthly' accounts of his discoveries concerning the aurora borealis and also wrote: 'History, Theory, and Practice of the Electric Telegraph' (1860); 'The Speaking Telephone' (1878): 'Bell's Electric Speaking Telephone' (1884); 'The Electric Telephone' (1890); etc.

Prescott, Oliver, American soldier: b. Groton, Mass., 27 April 1731; d. there 17 Nov. 1804. He was graduated from Harvard in 1750 and engaged in the practice of medicine. He was an officer in the State militia with rank as major, lieutenant-colonel, and in 1776 became a member of the board of war. In 1777 he was elected to the supreme executive council of his State, and in 1778 received rank as third major-general of militia. He resigned soon after his promotion to second major-general in 1781 and was empowered by the government to cause the arrest of any person whom he should consider dangerous to the commonwealth. In 1779 he was made judge of the probate court of Middlesex County, Mass., and played an important part in the suppression of Shays' rebellion in 1786-7.

Prescott, William, American soldier, brother of O. Prescott (q.v.): b. Groton, Mass., 20 Feb. 1726; d. Pepperell, Mass., 13 Oct. 1795. He served with the rank of lieutenant in the expedition against Nova Scotia under Wilson in 1755, and was offered a commission in the British army. He declined the honor and lived in retirement until the battle of Lexington in 1775 when he organized a regiment of which he became colonel, and joined the Continental camp at Cambridge. At the battle of Bunker Hill he was very conspicuous, really commanding the patriot forces and displaying the greatest courage and ability. He served in the Continental army two years and then retired from active duty with the exception of a short service as a volunteer at Saratoga in 1777. He was a member of the Massachusetts legislature for several years. Consult Parker, 'Colonel William Prescott, the Commander in the Battle of Bunker's Hill' (1875).

Prescott, William Hickling, American historian: b. Salem, Mass., 4 May 1796; d. Boston 28 Jan. 1859. In 1811 he entered Harvard College, and graduated in 1814. He long had trouble with his eyesight, which eventually became so weak that during the latter half of his life he could read only for a few moments at a time, and could scarcely see to write at all. He had early resolved to devote himself to a literary life, and soon after leaving college went to Europe, and spent two years in traveling through England, France, and Italy. The subject for which his inclination and abilities more especially fitted him was history, and he published his 'History of the Reign of Ferdinand and Isabella the Catholic' in 1838. The success which this achieved was most decisive. It was received with the utmost enthusiasm both in America and Europe; was soon translated into French, Spanish, and German; and its author was elected a member of the Royal Academy of Madrid. Prescott's next work was the 'History of the Conquest of Mexico, with a Preliminary View of the Ancient Mexican Civilization, and the Life of the Conqueror Hernando Cortez' (1843), which was received with equal favor, and in 1847 appeared the 'History of the Conquest of Peru, with a Preliminary View of the Civilization of the Incas.' Prescott now began the 'History of the Reign of Philip II.,' and no pains nor expense were spared by him to render the result commensurate with the undertaking. He received the most liberal co-operation from all quarters, public and private, and everywhere both public and private collections were thrown open to his inspection. In 1855 the first two volumes of the work appeared entitled, 'The History of the Reign of Philip II., King of Spain,' and in 1858 the third volume. In 1856 Prescott published an edition of Robertson's 'History of the Reign of Charles V.,' with notes and supplement, containing an account of the emperor's life after his abdication.

The labors of Prescott afford a remarkable instance of the success of indomitable industry and perseverance carried out in the face of what might otherwise appear almost insurmountable obstacles. Partial blindness preventing him from consulting personally the authorities from which he drew his materials, he had them read aloud to him. His first reader knew, however, no language but English. The historian «taught him,» as he says, «to pronounce the Castilian, suited, I suspect, much more to my ear than to that of a Spaniard.» He afterward obtained the services of a reader acquainted with several of the continental languages. Prescott's contemporaries laid strong emphasis, and not unjustly, on the thoroughness of his research. But unfortunately modern discovery has done much to correct his pictures of early American civilization, for his information on which he had no recourse save the Spanish chroniclers. Hence 'The Conquest of Mexico' and 'The Conquest of Peru' are now to be valued less for their historical accuracy than for the sweep of the narrative and unfailing interest of the style. Indeed, this «easy flow of language» and «faultless lucidity,» praised by Bancroft, is everywhere apparent in Prescott's work. He has not escaped the charge of too highly coloring his scenes for the sake of dramatic effect. He was not an analytical investigator, but rested content with a splendid synthetic arrangement of the concrete facts which he sincerely labored to obtain. This artistic sense and breadth of scope gave to his work an interest and a popularity not known in the case of many historians. A collection of eminent opinions on Prescott may be seen in the familiar 'Dictionary of Authors,' by Allibone. His contributions to periodicals were collected under the title of 'Biographical and Critical Essays' (New York, 1845; London, 1861). A complete edition of his work has been published in 15 volumes (new ed. 1890). Consult the 'Life' by Ticknor (1864); Ogden, 'William Hickling Prescott' (1904).

Prescott, Ariz., city, county-seat of Yavapai County; on the Santa Fé, P. & P. railroad; about 135 miles north of Phœnix, the capital of the Territory. The plateau upon which the city is situated has here an altitude of about 5,000 feet. Prescott was formerly the capital of the Territory. It is in the midst of a rich mining region; the chief minerals mined in the vicinity are copper, silver, and gold. Considerable attention is given to stock raising and there is some lumbering. There is here Saint Mary's Hospital and home for children, and Saint Mary's Sanitarium. The educational institu-

WILLIAM HICKLING PRESCOTT.

tions are Saint Joseph's Academy, Saint Xavier's Indian School, public and parish schools, and a public library. Pop. (1890) 1,759; (1900) 3,559; (1910) 5,092.

Prescrip'tion, in medicine, a statement or formula, usually in writing and made by a physician, containing directions for the preparation and use of medicines or remedies for a patient. Formerly prescriptions were written altogether in Latin, but in this country and in Scotland English is now chiefly used for the directions, Latin being reserved for the names of ingredients. In England both prescriptions and directions are still usually written in Latin. In prescribing the physician may, from the nature of the case, use an officinal or extemporaneous preparation. Prescriptions are now much more simple than formerly. The parts of a regular prescription are four, as follows: (1) The superscription, with the date, name of patient, and the sign ℞, an abbreviation of *recipe* (take); (2) the inscription, that is, the body of the formula, containing names and names of ingredients; (3) the subscription — directions for the apothecary; (4) the signature, comprising directions to the patient regarding the use of the medicines or remedies prescribed, and followed by the signature (sometimes initials) of the physician. The prescription is composed of ingredients each designed for a particular purpose. The most active of these is called the *base;* the *adjuvant* is meant to promote the action of the first; the *corrigent* or corrective is intended to modify that action; and to these is added the *excipient,* also called the *vehicle,* etc., for the purpose of imparting to the whole a form or consistency convenient and agreeable for use.

Presenta'tion, in ecclesiastics, means the nomination of one or several candidates to a vacant office in the church. In ecclesiastical benefices the usual rule is that if the patron fails to present within six months after a vacancy has been intimated to him, the *jus devolutum* takes place; in other words, the patron loses his right, which in consequence devolves on the party before whom the presentation should have been laid, as the bishop under Episcopacy, and the presbytery under Presbyterianism.

Presentation at Court. See COURT, PRESENTATION AT.

Present'ment, in law, is properly speaking the notice taken by a grand jury of any offence, from their own knowledge or observation, without any bill of indictment being laid before them at the suit of the crown; as the presentment of a nuisance, a libel, or the like, upon which the officer of the court must afterward frame an indictment before the party presented can be put to answer it. The term is also used to include inquisitions of office, and indictments by a grand jury; or to express the formal notice taken in copyhold courts of the deaths of tenants, surrenders and admittances taken out of court, and similar circumstances.

Preservation of Food. See FOOD PRESERVATION.

Preservation, Fort. See OSWEGATCHIE.

Preser'vatives. See ANTISEPTIC.

Presidency. See UNITED STATES, *Presidency.*

President, signifying he who presides. It is used for: (1) the principal member of a society or association, who takes the chair when present at meetings; (2) the chief official of a company or board; (3) the head of a university or college, or of a learned faculty; (4) the elected chief of a republic. In the United States the president is the chief executive of the government. He is commander-in-chief of the army and navy of the country, and has the nomination of most of the executive officers of the government, besides a large number of judicial and administrative functionaries. He is elected for a term of four years, and is eligible for any number of re-elections, though, in conformity with the precedent set by George Washington, no President has yet been elected more than twice. The President has a veto power and unlimited pardoning prerogative as to offenders against National laws. His salary is $50,000 a year, and his residence, during his presidency, is the White House in Washington. He is elected by an electoral college, which in some contingencies makes the choice by States, and he may receive a minority of the popular vote and yet be legally chosen to the office. In case of his death or total disability the functions of the office devolve on the Vice-President, who is elected coincidently with the President, and is the presiding officer of the Senate. The following is the list of Presidents up to the present: George Washington, 1789 and 1793; John Adams, 1797; Thomas Jefferson, 1801 and 1805; James Madison, 1809 and 1813; James Monroe, 1817 and 1821; John Quincy Adams, 1825; Andrew Jackson, 1829 and 1833; Martin Van Buren, 1837; William Henry Harrison (died 4 April 1841), 1841; John Tyler (elected as Vice-President), 1841; James Knox Polk, 1845; Zachary Taylor (died 9 July 1850), 1849; Millard Fillmore (elected as Vice-President), 1850; Franklin Pierce, 1853; James Buchanan, 1857; Abraham Lincoln (assassinated 14 April 1865), 1861 and 1865; Andrew Johnson (elected as Vice-President), 1865; Ulysses S. Grant, 1869 and 1873; Rutherford B. Hayes, 1877; James A. Garfield (died by assassination 19 Sept. 1881), 1881; Chester A. Arthur (elected as Vice-President), 1881; Grover Cleveland, 1885; Benjamin H. Harrison, 1889; Grover Cleveland, 1893; William McKinley, 1897 and 1900 (assassinated 6 Sept. 1901); Theodore Roosevelt (elected as Vice-President) 1901; 1905; William H. Taft, 1909.

President, The, the name of an American frigate, the flagship of Capt. John Rodgers in the early part of the War of 1812 (q.v.). It was a sister ship of the Constitution and the United States. It defeated the British ship Endymion on 15 Jan. 1815, but was obliged to surrender to her consorts.

President's March, the title of a popular American national air composed in 1789 by Pfyles, leader of the orchestra at the John Street Theatre, New York. It was played for the first time on Trenton Bridge as Washington rode over on his way to be inaugurated. Later Hopkinson set the words of 'Hail Columbia' to the air, and it became immensely popular.

Presidential Bee, in American politics, an expression referring to a man who has aspirations to the presidential chair and uses his influence accordingly. Such a one is said to have the "presidential bee in his bonnet."

Presidential Electors. See Electors, United States Presidential.

Presidential Succession, the order in which a vacancy in the office of the President of the United States can be filled pending a new election. The 49th Congress passed a measure entitled "An Act to provide for the performance of the duties of the office of President in the case of removal, death, resignation, or inability both of the President and Vice-President." The measure was approved by the President 19 Jan. 1886. The text is as follows:

§ 1. Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in case of removal, death, resignation, or inability of both the President and Vice-President of the United States the Secretary of State, or if there be none, or in case of his removal, death, resignation, or inability, then the Secretary of the Treasury, or if there be none, or in case of his removal, death, resignation, or inability, then the Secretary of War, or if there be none, or in case of his removal, death, resignation, or inability, then the Attorney-General, or if there be none, or in case of his removal, death, resignation, or inability, then the Postmaster-General, or if there be none, or in case of his removal, death, resignation, or inability, then the Secretary of the Navy, or if there be none, or in case of his removal, death, resignation, or inability, then the Secretary of the Interior, shall act as President till the disability of the President or Vice-President is removed or a President shall be elected: Provided, That whenever the powers and duties of the office of President of the United States shall devolve on any of the persons named herein, if Congress be not then in session, or if it would not meet in accordance with law within 20 days thereafter, it shall be the duty of the person on whom said powers and duties shall devolve to issue a proclamation convening Congress in extraordinary session, giving 20 days' notice of the time of meeting.

§ 2. That the preceding section shall only be held to describe and apply to such officers as shall have been appointed by the advice and consent of the Senate to the offices therein named, and such as are eligible to the office of President under the Constitution, and not under impeachment by the House of Representatives of the United States at the time the powers and duties of the office shall devolve upon them respectively.

Presidio, prę-sĭd'ĭ-ō, a Spanish word which means "a fort." It is applied especially to four fortified Spanish forts on the coast of Morocco: Alhucemas, Ceuta, Melilla, and Peñon de Velez. The military settlements made by the Spaniards in California have usually retained the name "Presidio" for the military posts. The chief Presidios of Spanish California were massive forts at Los Angeles, Monterey, San Diego, and Santa Barbara.

Presidio of San Francisco, Cal., a United States military post in the suburbs of the city of San Francisco. It contains 1,480 acres. It was established as a military post by Spain, and Mexico continued it until it was ceded to the United States in 1848. It was established as a United States military post in 1850.

Press, in mechanics, see Metal-working Machinery; in printing, see Printing Press.

Press, Freedom of the, the right of every citizen to print whatever he chooses, which at the same time does not prevent his being amenable to justice for the abuse of this liberty. The right of printing rests on the same abstract grounds as the right of speech, and it might seem strange to a man unacquainted with history that printing should be subjected to a previous censorship, as it is in some States, and has been in all, any more than speaking, and that the liberty of the press should be expressly provided for in the constitutions of most free States. But when we look to history we find the origin of this, as of many other legislative anomalies, in periods when politics, religion, and individual rights were confusedly intermingled. It is only since men's views of the just limits of government have become clearer that the liberty of the press has been recognized as a right; and to England we are particularly indebted for the establishment of this principle. The existence of a censorship of the press was for centuries, however, deemed an essential to the safety of all European governments. Liberty of printing, as we understand it, is a comparatively modern notion; Milton's plea for a free press met with no response from his own party, nor for very many years later was it the cue of any party in the English commonwealth to refrain from suppressing the writings of their political opponents. In England the liberty of the press, soon after printing was introduced, was regulated by the king's proclamations, prohibitions, charter of license, etc., and finally by the court of star-chamber. The Long Parliament, after their rupture with Charles I., assumed the same power. The government of Charles II. imitated their ordinances, and the press did not really become free till the expiration of the statutes restricting it in 1693, after which it was found impossible to pass new laws in restraint of it, and it has remained free ever since, the last restriction being done away with on the abolition of the newspaper stamp duty, in 1856. Such legal checks as remain are merely intended to prevent outrages on religion or decency, to protect subjects from defamation, and to conserve the copyright of authors. The constitutions of many of the United States declare, as we should expect, for the liberty of the press. The same may be said of all the South American republics.

Press Associations, in journalism, (1) a co-operative organization for gathering and distributing information and reports of current events for daily newspapers; (2) an association of editors and newspaper writers for social intercourse and for the discussion of subjects patent to journalism. Of the latter class there are in the United States a national organization, two tri-State, and numerous State organizations which meet annually. The press association for the dissemination of news is a product of 19th century journalism and was unknown prior to 1848. In that year Baron Julius Reuter of Prussia organized a continental press association for the purpose of serving the leading newspapers of European capitals with a report of the important current happenings of continental Europe. The plan met with immediate success and in the following year, Baron Reuter visited London and secured the co-operation of the more prominent daily newspapers of the British capital, and from this beginning has grown the great news-gathering enterprises of the present day. "Reuter's" has become a familiar word throughout the English-speaking world, the organization maintaining resident correspondents in every country and in every large city on both hemispheres. In 1868 there was formed a subsidiary concern called the Press Association of London, which serves the provincial newspapers of the United Kingdom with daily news reports. As the telegraph was perfected and extended, other associations, the Central News Agency of London, Havas' Continental Agency, the Exchange Company, Dalzel's Cable News, and the National Press Agency, came into existence abroad, and during the Franco-Prussian war, the South African war, and other similar events, great rivalry arose between these organizations.

In the United States the Associated Press of New York was organized prior to 1860, and the Western Associated Press was formed during the Civil War period. The latter was a strong co-operative organization, and for many years it was an important factor in the business of news gathering in this country. For 20 years the New York Associated Press and the Western Associated Press worked together in harmony. The wires of the Western Union Telegraph were utilized for transmitting reports, and thousands of miles of leased wires were constantly in use. In 1882 the United Press was formed, using the Postal Telegraph wires for the transmission of news, and in 1883 a third and smaller rival, the Press News Association, entered the field. Meanwhile dissensions arose over contracts between the New York and the Western Associations, and the disputes were carried into the courts. The evidence showed that the Western Associated Press had made contracts for franchises between January 1883 and January 1893 with newspapers in the far West, calling for payments under the contracts of $118,410. Of this amount the books showed that $85,294 had actually been paid in. One half of this amount was claimed by the New York Associated Press as its share of the money collected from such sales of franchises. Suits and counter suits were commenced and the Western Associated Press was finally dissolved. A new Associated Press was organized under the laws of Illinois and for several years a close rivalry existed between this company and the United Press. Then dissensions arose and in 1900 the Associated Press was reorganized and reincorporated under the laws of New York State. In the meantime the Press News had died from financial mismanagement and soon afterward the United Press was wrecked. The Associated Press now began a prosperous career with no rival worthy of the name. The New York City Press Association, a local concern, was incorporated as a part of the Associated Press, which also began an exchange arrangement with Reuter's Agency in Europe. All the New York newspapers with the exception of the *Sun* receive their foreign and domestic reports from the Associated Press. The *Sun* organized an independent news-gathering service, called the Laffan Bureau, and from the ruins of the United Press, co-operated with a number of newspapers between New York and San Francisco, thus building up a creditable organization independent of the Associated Press. A third organization, the Scripps-McRae Press (Western service) and the Publishers' Press (Eastern service) in 1903, was serving news to several hundred newspapers. These two companies are practically one, dividing the eastern and western fields between them. The three press associations were strenuous rivals during the Spanish-American War, and special correspondents were sent with the American fleets and the armies in the field. Reporters were also stationed at every port on the southern coasts. An Associated Press correspondent was with Dewey at the battle of Manila Bay. All three associations maintain resident correspondents in the larger American cities, and in London, Paris, Rome and the foreign capitals.

Closely allied with the press associations is the newspaper syndicate, which instead of furnishing current daily news, supplies special articles, correspondence, fiction and miscellaneous literary material to thousands of daily and weekly newspapers throughout the country. S. S. McClure was the pioneer in this field, followed by the American Press Association, the Bacheller and Johnson syndicate, the A. N. Kellogg Newspaper Union, the Leslie Syndicate, the Bulletin Press Association, and numerous others. The syndicate is enabled, by its sales of the same article to many customers, to purchase matter quite out of the reach of the individual newspaper, and to sell it on terms that each can afford. The scheme is found to be so advantageous that practically all the leading newspapers use syndicate matter to a considerable extent. Besides the firms engaged primarily in the syndicate business, several leading metropolitan daily newspapers, notably the New York *Herald* and the *American*, dispose of their own matter to papers published in other cities.

WILL M. CLEMENS,
Editorial Staff, 'Encyclopedia Americana.'

Press Censorship. See CENSORSHIP OF THE PRESS.

Press-gang, the name given in England to a detachment of seamen who (under the command of a naval officer) were empowered, in time of war, to take any seafaring men and oblige them to serve on board the king's ships. See IMPRESSMENT.

Pressburg, prĕs'boorg, or **Presburg** (Magyar, *Pozsony;* Slavonic, *Presburek*), Austro-Hungary, (1) town in the west of Hungary, capital of the county of Pressburg; on the Danube, 35 miles east of Vienna. The site of the town is remarkably fine, being in the form of a semicircle, bounded on the south by the Danube, from the banks of which it gradually ascends to the west and north toward ramifications of the Carpathians; and an extensive plain, covered with gardens, vineyards, meadows, and corn-fields, forms its boundary on the east. The houses are built of brick and stone, and of two or three stories. The edifices most deserving of notice are the Landhaus, or Hall of the Diet, in which the chambers of the kingdom used to meet; the cathedral, a huge Gothic pile with a lofty steeple, less remarkable as a church than as the place where the kings of Hungary were formerly crowned; the monasteries, the Jesuit church, a synagogue, the town-house, theatre, bishop's palace, orphan hospital, and barracks. The manufactures consist of woolens, silks, leather, and tobacco. The trade, chiefly in corn, is extensive. Outside the town there used to be an artificial mound called the Coronation Hill, to which the newly crowned kings of Hungary rode in grand procession and brandished the sword of Saint Stephen toward the north, south, east, and west, signifying thereby that they undertook to defend the kingdom from danger, come from which quarter it might. Pressburg is a place of very great antiquity. In 1541, when the Turks captured Buda, it became the capital of Hungary, till the Emperor Joseph II. restored it to Buda. The peace by which Austria ceded Venice to France and the Tyrol to Bavaria was concluded here in 1805. Pop. (1900) 65,867. (2) The county of Pressburg, area about 1,250 square miles, is traversed by part of the Carpathian chain in the north, in the south it is flat and fertile. It is watered by the Danube. March, Waag, and Dudwaag, and yields corn and grapes. The large forests furnish abundance of timber. Pop 331,370.

Pressensé, Edmond Dehault de, ĕd-môṅ dė-ōlt dė prä-sŏṅ-sā, French Protestant theologian: b. Paris 3 June 1824; d. there 8 April 1891. He studied theology under Vinet, Tholuck, and Neander, and in 1847 was appointed pastor of the independent Chapelle Taitbout in Paris. Throughout his whole career he was an eloquent opponent of the connection of church and state, and an able supporter of evangelical Christianity. He also took part in politics, in 1871 was elected to the National Assembly by the department of the Seine, and thenceforward constantly sought to consolidate the republic on a thoroughly liberal basis. He was elected a life senator in 1883. He founded the 'Revue Chrétienne' in 1854 and conducted it till his death. His published works which have appeared in an English version include: 'Histoire des Trois Premiers Siècles de L'Eglise Chrétienne' (1888); 'L'Eglise et la Révolution Française' (1869); 'Jesus-Christ, son Temps, sa Vie, son Œuvre' (1866; 7th ed., 1884), a reply to Renan's 'Vie de Jesus'; 'Etudes Contemporaines' (1880), translated into English as 'Contemporary Portraits'; 'Les Origines' (1883–7), translated as 'The Study of Origins'; 'Variétés Morales et Politiques' (1885); 'Alexandre Vinet' (1890); 'Etudes Evangeliques.' Among other works may be cited 'La Liberté Religieuse en Europe depuis 1870' (1874). Consult biographies by Loyson (1891), Roussel (1894).

Pressure. See FORCE; POWER.

Pressure Figures, in mineralogy, are certain radiating lines developed by the pressure of a point on a crystal or cleavage surface. They are diagonal to the percussion figures (q.v.).

Pres'ter John (Priest or Presbyter John), a semi-legendary character of the Middle Ages. It was reported by travelers that there was a Christian prince who reigned in the interior of Asia under his name, and the same story was also known to the Crusaders. Albert of Aix and Otho of Freisingen speak of him in the 12th century; Rubruquis, in the 13th, attributes the name of Prester John to a Nestorian prince, Ung Khan, who had reigned in Karakoram over two Mongol tribes, and perished in a war against Genghis Khan, above half a century before the time of his journey. Other travelers of the 13th century also mention this personage. Who this Prester John was cannot be determined. The supposition that he was one of the chief priests of the Lamaites does not agree with the position assigned to his residence by the travelers, nor do any etymological explanations seem satisfactory. The Portuguese in the 15th century, hearing a story of a Christian prince in the interior of Africa, whose name was Ogan, and who was in fact the negus (king) of Abyssinia, and being misled by the resemblance of the names Ogan and Ung Khan, made the mistake of transferring the throne of Prester John from Asia to Africa and giving the name to the Abyssinian prince. Consult: Oppert, 'Der Presbyter Johannes in Sage und Geschichte' (2d ed., 1870); and 'The Book of Sir Marco Polo' (Hakluyt Society, 1874).

Pres'ton, Harriet Waters, American translator and novelist: b. Danvers, Mass., 1843. At an early age she became noted as a linguist, and has since achieved a brilliant reputation as a translator from the Latin and Provençal languages, and as an essayist. In addition to translations of Mistral's 'Miréio' (1873), Virgil's 'Georgics' (1881), and several other works, she has published of her own original work: 'Aspendale' (1881); 'Troubadours and Trouvères' (1876); 'A Year in Eden,' with Louise Dodge (1886); 'Private Life of the Romans' (1893); 'Love in the 19th Century' (1873).

Preston, John Smith, American politician and soldier: b. near Abington, Va., 20 April 1809; d. Columbia, S. C., 1 May 1881. He was graduated from the Hampden-Sidney College in 1824, studied at the University of Virginia and at Harvard, and after an extended tour of Europe settled in Columbia. He was a member of the South Carolina legislature in 1848–56 and gained a high reputation as an orator. He openly and ardently upheld the secession movement, headed his State's delegation to the Charleston convention in 1860, and in the following year became one of the commissioners to Virginia, where he made a brilliant speech urging secession upon that State. He was engaged at the first battle of Bull Run and afterward was assigned chief of the conscript department with the rank of brigadier-general. After the war he lived in Europe for a time, and after his return to the United States remained a bitter opponent of the government until his death.

Preston, Margaret Junkin, American author: b. Philadelphia, Pa., 1825; d. Baltimore, Md., 28 March 1897. She was married to John T. L. Preston of the Virginia Military Institute in 1857 and from that time until her husband's death lived in Lexington, Va. In 1855 she translated the Latin hymn 'Dies Iræ' and in 1856 published her first book, a novel entitled 'Silverwood.' Her subsequent work is almost entirely in verse and is characterized by deep religious feeling and an ardent espousal of the Confederate cause. She published: 'Beechenbrook' (1866); 'Old Songs and New' (1870); 'For Love's Sake' (1886); 'Aunt Dorothy' (1890); etc. Her diary, giving an interesting and valuable history of her life in the South, is published in part in Elizabeth Preston Allan's 'Life and Letters of Margaret Junkin Preston' (1903).

Preston, Thomas Scott, American Roman Catholic clergyman: b. Hartford, Conn., 23 July 1824; d. New York 4 Nov. 1891. He was graduated from Washington (now Trinity) College in 1843, from the General Theological Seminary of the Protestant Episcopal Church in 1846, and held assistant rectorates in New York. Subsequently he entered the Roman Catholic Church, and after study at St. Joseph's Seminary, Fordham, N. Y., was ordained priest in 1850. He became chancellor of the diocese of New

York, and in 1861 rector of St. Ann's, New York. In 1881 he was made monsignor, and in 1888 prothonotary apostolic. He vigorously opposed the land and labor movement of Henry George (q.v.), and was active in urging the excommunication of Dr. McGlynn (q.v.). Among his many controversial and devotional works are: 'Life of St. Vincent de Paul' (1866); 'Lectures on Christian Unity' (1867); 'Lectures on Reason and Revelation' (1868); 'Protestantism and the Bible' (1880); and 'God and Reason' (1884).

Preston, William Campbell, American legislator and educator: b. Philadelphia, Pa., 27 Dec. 1794; d. Columbia, S. C., 22 May 1860. He was graduated from the South Carolina College in 1812, studied law and was admitted to the bar in 1820. He established a law practice in Columbia, S. C., the next year, and speedily became prominent in his profession, excelling as a jury lawyer. He sat in the State legislature in 1828 and in 1830–2, where he boldly advocated nullification and won a high reputation as an orator. In 1836 he was elected to the United States Senate, but refused to act with his colleague, Calhoun, in the latter's support of Van Buren, and resigned his office in 1842. In 1845–51 he was president of the South Carolina College and proved an able and successful administrator. He established the Columbia Lyceum, which he endowed with his own library of 3,000 volumes. Consult O'Neall, 'Bench and Bar of South Carolina.'

Preston, England, an important manufacturing town of Lancashire, 28 miles northeast of Liverpool; on a height above the north bank of the Ribble, near the head of its estuary, and on the London & Northwestern and other railways. The river is spanned by five bridges. The handsome central railway station cost about $1,000,000. Other important buildings are the Gothic town hall; court-house, in the Doric style; a new infirmary, the house of correction, the custom-house, corn-exchange, new gas-offices, large and handsome market-shed, extensive barracks, workhouse, theatre, and assembly-rooms; the Literary and Philosophical Institution, provided with a library, and museum; the Harris Institute of Literature, Art, Science, and Technical Instruction (formerly the Mechanics' Institute, and now greatly enlarged); the Free Public Library and Museum, in the Grecian style, with many valuable paintings, etc. The ecclesiastical edifices include a number of established churches, besides Roman Catholic and other chapels. Among the former Christ Church is admired for the purity of its Norman architecture; and the parish church, which has been rebuilt in the decorated style of the 14th century, with a spire 196 feet high, is also a fine building. St. Walburge's Roman Catholic chapel, which has a beautiful spire 306 feet high, ranks as the most splendid place of worship in Preston. The town is supplied with water from reservoirs situated near Longridge, 18 miles northeast of Preston, with a capacity of 405 millions of gallons. On the south side of the town are two beautiful public parks, and on the north side of the town is the Moor Park.

The original staple manufacture of the town was linen, which is still woven, but has been completely eclipsed by the cotton manufacture, first introduced in 1777. There are steam saw-mills, electrical engineering works, machine-shops, iron and brass foundries, railway-carriage works, breweries, malt-houses, roperies, tanneries, etc. A considerable shipping trade is carried on, though it was long obstructed by the condition of the Ribble. Since 1884 the river has been canalized and a dock of 40 acres built, besides two graving-docks and a timber-pond of 25 acres, with the necessary approaches, basins, gates, etc., and a very considerable increase in the trade has now taken place.

Preston is said to have risen on the decay of Ribchester, the Roman Rigodunum, situated about 11 miles farther up the river. Its name, originally Priest's town, it owed to the number of religious houses which it contained. About 600 it was a Saxon settlement; in 1323 it was taken and burned down by Robert Bruce; in 930 its first parish church was built; in the great civil war it espoused the Royalist cause, and suffered severely during the contest, having been twice captured by the Parliamentarians, who on the latter occasion were headed by Cromwell in person; in the rebellion of 1715 it was occupied by the Jacobite forces, who erected barricades and made a brave resistance, but were ultimately obliged to surrender at discretion. Pop. about 125,000.

Prestonburg, Engagements at and near. In September 1861 Col. John S. Williams began to organize a Confederate force at Prestonburg, in eastern Kentucky, to operate in the interior of the State. On 8 November Gen. William Nelson, who had advanced against him with three Ohio regiments, detachments of Kentucky infantry and cavalry, and two sections of artillery, with a part of this force encountered a detachment thrown forward by Williams to cover his withdrawal. After a well-contested engagement at Ivy Mountain, Williams was forced from his position and retreated through Pound Gap into Virginia, with a loss of 10 killed, 15 wounded, and 40 missing. Nelson was recalled to Louisville, and Williams returned to Prestonburg. Gen. Humphrey Marshall had been ordered, 1 November, to the command of the Confederate forces in eastern Kentucky, including those of Williams and soon had in addition two Virginia regiments and a battery of four guns, making a total force of about 2,400 men, who were badly clothed, many of them barefooted, and generally badly armed, many of the men having only shotguns and squirrel-rifles. In the beginning of January 1862 Marshall had the greater part of his command intrenched near Paintsville, on the main branch of the Big Sandy River, a few miles north of Prestonburg. On 17 December Gen. Buell assigned Col. James A. Garfield to the command of a brigade of about 3,000 men, partly cavalry, and sent him against Marshall and to clear the valley of the Big Sandy. On the 23d, when Garfield began his march up the course of the river, the greater part of the brigade was concentrated at Louisa, on the Big Sandy. On 6 Jan. 1862, after driving in several scouting parties, Garfield arrived within seven miles of Paintsville. Marshall, well informed of his approach, fell back from Paintsville on the night of the 5th to the forks of Middle Creek, about three miles above Prestonburg. Garfield advanced through Paintsville, defeated Marshall's cavalry at the mouth of Jennis' Creek on the 7th, and on the morning of the 10th attacked Marshall on Middle Creek with cavalry and was repulsed by artillery alone. Garfield now attacked with infantry and the fight continued from noon to near dark with varying success, several Union advances being repulsed; but Marshall finally abandoned his position, though not retiring from the field until next morning, when, being out of food for his men, he marched to Martin's Mill. Garfield did not pursue. He crossed the river on the 11th and occupied Prestonburg, and on the 12th and 13th withdrew to Paintsville. Both sides claimed the victory. Garfield had 1,700 men on the field, and his loss was two killed and 25 wounded. Marshall had 1,500 engaged, and lost 11 killed and 15 wounded. Consult: 'Official Records,' Vol. VII.; The Century Company's 'Battles and Leaders of the Civil War,' Vol. I.

E. A. CARMAN.

Prestonpans, prĕs-tôn-pănz', Scotland, a small town in the county of Haddington, on the Firth of Forth, nine miles east of Edinburgh, celebrated for the battle fought in the vicinity, 21 Sept. 1745, when the Highlanders, headed by Prince Charles, defeated the royal troops commanded by Sir John Cope. Pop. about 2,000.

Prest'wich, SIR Joseph, English geologist: b. London 12 March 1812; d. Shoreham, Sussex, 23 June 1896. He was educated at University College, London, and continued his geological studies though engaged in business as a wine merchant. The Geological Society conferred a medal upon him in 1849, and he received like honors from the Royal Society in 1865 and the Institute of Civil Engineers in recognition of his contributions to science. In 1870 he became president of the Geological Society and in that year he retired from business. He became professor of geology at Oxford in 1874 and though advanced in years for the adoption of a new profession his vast learning and the vigor with which he approached his new task enabled him to fill the position with great success. His most important researches relate to the Tertiary deposits, which he rearranged and reclassified, and evidences concerning the existence of the prehistoric man. He also applied his knowledge to the practical question of obtaining from underground waters a better supply for cities. He retained his professorship at Oxford until 1888, was connected with various important scientific societies and in 1896 was knighted. His writings include about 140 papers of which the most notable are published in his 'Geology' (1886–8) and 'Collected Papers on Some Controverted Questions in Geology' (1895). Consult Lady Prestwich, 'Life and Letters of Sir Joseph Prestwich' (1899).

Presump'tion, in law, is a supposition held as good or real before it is shown or certainly known to be so. Presumptions are either *juris*, or *juris et de jure*. A legal presumption in law is one established in law till the contrary be proved. Thus, a person who has the possession of goods is presumed to be the owner, or a man is assumed to be innocent unless the contrary be proved. Presumptions are adopted from the necessity of arriving at some conclusion or other in most cases where the evidence is general or inconclusive. Thus, where a person has disappeared and has not been heard of, the law will in general presume that he is still alive, unless after a lapse of time considerably exceeding the ordinary duration of human life; but if there be evidence of his continuous unexplained absence from home, and of the non-receipt of intelligence concerning him for a period of seven years, the presumption of life ceases.

Pretender, The. See STUART, JAMES FRANCIS EDWARD.

Pretender, The Young. See CHARLES EDWARD STUART.

Preti, prā'tē, **Mattia.** See CALABRESE.

Pretoria, prẹ-tō'rĭ-ạ, South Africa, capital of the Transvaal Colony (q.v.); situated a short distance north of the small river Aapies, a tributary of the Crocodile, 4,500 feet above sea-level, 32 miles northeast of Johannesburg, 349 miles by rail west of Delagoa Bay, and 1,040 miles by rail northeast of Cape Town. The town is regularly laid out and many of the streets are planted with splendid willow-trees. The most important public buildings are: the government buildings, in Church Square, surmounted by a statue of Liberty; the post-office; the Dutch Reformed Church, in the centre of Church Square; the Anglican cathedral of St. Alban; a Roman Catholic church, with school and convent buildings; the Jewish Synagogue, a handsome building; the new market buildings; a palace of justice, in course of erection for the reception of the law courts; a public library, containing English and Dutch books; a museum; a gymnasium and training institute. The town is lighted by electricity, and public waterworks were opened in 1891. Just outside the town are the barracks formerly occupied by the Transvaal State Artillery, and near them the prison is situated. In 1896 the Boer authorities began the construction of a circle of six forts round the town, which since the war have been dismantled. Pretoria was founded in 1855, and was named in honor of Andries Pretorius, the first president of the South African Republic. In 1863 it replaced Potchefstroom as the seat of the central administration. In December 1880 the British garrison in Pretoria was besieged by a force of Boers, and on the retrocession of the country in the following year the town was evacuated by the British troops. The gold-rush which began about 1886, and the working of the natural wealth of the neighboring Witwatersrand, had a great influence upon the condition of Pretoria, which was rapidly improved in respect of architecture and sanitation. On 5 June 1900 the town was occupied, practically without opposition, by a British force under Lord Roberts, and then became the headquarters of the British operations in the South African war (q.v.). The population before the war was about 12,000.

Pretorius (Dutch, prā-tō'rĭ-ŭs), **Marthinas Wessels,** Boer soldier and politician: b. Natal 1827; d. Potchefstroom, South Africa, 19 May 1901. He took part in the "Great Trek" of 1836, and in 1852 became commandant-general of the Boers. In 1860 he was elected president of the Orange Free State, in 1864 of the South African Republic. Re-elected in 1869, he soon afterward resigned. After Kruger's election in 1883, Pretorius took small part in the affairs of the republic, being persistently opposed to the war policy against Great Britain as destined eventually to subvert the independence it sought to secure. Pretoria, the capital of the Transvaal, was named in his honor.

Preventive Medicine. Generally the term "preventive medicine" has been regarded as almost synonymous with public hygiene, and its application has been confined to the operations of the sanitary authorities in the prevention of the infectious and communicable diseases. These operations have not in the past included even all of the more important communicable diseases, although the list in recent years has been considerably extended. Formerly cholera, plague, yellow fever, typhus fever, epidemic dysentery, smallpox, scarlet fever, diphtheria, and typhoid fever practically comprised all of the diseases which came specifically under the supervision of the public health authorities. Recently this list has been considerably increased by some sanitary boards. Many of the diseases referred to — for example, cholera, plague, yellow fever, epidemic dysentery — have practically passed from the supervision of the authorities, at least in the temperate zones, because either they no longer occur at all in these regions, or only occasionally a case or a group of cases appears and calls for specific action and supervision. The eradication of these epidemic diseases may be regarded as the greatest triumph of preventive medicine. It will of course be noted that public hygiene, or preventive medicine, in this restricted sense, has taken little or no cognizance as yet of many exceedingly important communicable diseases, such as syphilis, gonorrhœa, puerperal fever and, generally speaking, even of tuberculosis.

Preventive medicine in the proper sense has a very much broader scope than that indicated, and may be defined as the sum of all medical knowledge applicable to the prevention of disease — of all disease in the broadest sense, and not simply of the communicable diseases. It presupposes the widest knowledge of medicine, and has its essential foundation in our knowledge of the anatomy and causation of disease. Preventive medicine comprises therefore the prophylaxis of disease; it is general, comprising those measures which are applicable to the prevention of disease in the community (including especially the communicable diseases); and it is individual, as applied to the prevention of disease of all kinds in the individual members of the community. General prophylaxis refers to what are spoken of as preventable diseases, and these in the broad sense may be regarded as all of the infectious diseases which are communicable. Individual phrophylaxis has a still wider scope and includes the whole sum of medical knowledge as applied to the prevention of disease (of all varieties) and the prolongation of life. General prophylaxis and individual prophylaxis do not always run along wholly parallel lines; for what is best for the individual is not necessarily best for the community. Preventive medicine is an applied science, and includes all purely medical knowledge applicable to the attainment of its aim. In securing its aim preventive medicine necessarily improves the general physical well-being of the individual, and thus life is rendered not only longer, but happier.

General prophylaxis attains its purpose in different ways. Through the establishment of sea quarantine it attempts to exclude infectious diseases which are endemic. These are spoken of as "quarantinable diseases," and they of course must differ with locality, depending upon what communicable diseases are endemic in a locality. In the United States, plague, cholera, typhus fever, yellow fever, and leprosy are the diseases which the authorities especially attempt to exclude from the country. Scarlet fever, measles, diphtheria, and smallpox, being endemic, are not held at quarantine, but are referred to isolation hospitals for supervision until their termination. During recent years the quarantinable diseases have been almost completely excluded from this country. Occasionally a case has been admitted at some point, and a group of cases, or a localized epidemic, has followed; but in almost all instances the outbreaks have been of a restricted and local character. It does not seem probable that in North America there will ever again be any serious danger of the prevalence of cholera, plague, typhus fever, or leprosy. In dealing with the other communicable diseases specific methods have been devised, depending upon the nature of the disease and the method of its transmission. In some instances the attempt is made to destroy the cause, or prevent its entrance into the body; in other instances, to render the individual insusceptible to the cause and at the same time protect him from exposure to infection. For example, the cause of smallpox not being known, it is vain to attempt to destroy it in the individual; but as vaccination renders a person insusceptible to smallpox, it proves an absolutely efficient means for preventing the prevalence of this disease. In cities and countries where vaccination and revaccination are enforced smallpox rapidly disappears; and even when cases are introduced from without, the disease does not extend. Thus in Prussia, where there is compulsory vaccination in infancy and revaccination at different intervals later in life, smallpox practically does not exist. In different portions of the United States the prevalence of smallpox in epidemic form is determined in each instance by the thoroughness with which different communities have been vaccinated.

In typhoid fever the methods followed in prevention are of a different character. The typhoid bacilli which cause typhoid fever are practically always taken into the body through the mouth, usually in drinking-water or food. The commonest sources of infection are contaminated water, milk, and oysters, and also the direct infection of those in immediate contact with typhoid fever cases, by the transfer of the typhoid bacilli to the mouth on soiled hands, or from eating or drinking utensils. Aerial infection plays a small part in the causation of this disease. The prevalence of typhoid fever has been very greatly restricted by the protection of the sources of water-supply, by the application of sanitary measures to the collection of milk, and by proper disposal of sewage. Sewage is the medium through which the typhoid infection reaches the water-supply. Milk is infected, not when derived from the animal, but subsequently, from the washing of utensils with contaminated water, or in some similar way. As yet no active measures have been adopted by the sanitary authorities to prevent the contamination of shell-fish through the sewage-pollution of the water in which the shell-fish beds are situated. This is probably a much more common source of infection than has been generally supposed.

In the case of scarlet fever, measles, diphtheria, chickenpox, whooping-cough, and mumps, prophylactic measures comprise the removal of the sick, if possible, to special isolation hospitals designed for this purpose, and the adequate disinfection of clothing, rooms, furniture, bedding, etc., which may have become infected by contact with the sick. At present no other means are available, except in diphtheria, largely because of the lack of knowledge as to the exact causes of these diseases. In diphtheria, besides these measures, there is now a method for rendering the individual insusceptible to the disease for short periods by administering immunizing injections of diphtheria antitoxin. By these injections the individual may be rendered insusceptible to the disease (as in smallpox by vaccination), but the immunity is of short duration.

Many sanitary authorities are now adopting measures for the prevention of tuberculosis, which causes more deaths throughout the civilized world than any other single disease. Here again the problem of prophylaxis differs from that applicable to any of the other diseases mentioned. In tuberculosis the tubercle bacilli, which are the cause of the disease, are solely contained in the discharges from the diseased tissues, but the only form of tuberculosis (the disease may affect any organ or tissue of the body) in which the discharges containing the tubercle bacilli are likely to be a source of danger to others, is tuberculosis of the lungs, or pulmonary consumption. In this form, tubercle bacilli are frequently present in the expectoration in almost incredible numbers. The prophylaxis of tuberculosis is therefore practically comprised in the destruction of the expectoration of persons suffering from pulmonary tuberculosis at the time of its exit from the body. If this could be absolutely accomplished the transmission of tuberculosis from one person to another would be almost completely avoided. A common source of infection is probably present in the minute drops of atomized expectoration which are forcibly discharged into the air in coughing and sneezing, unless the mouth and nose are covered during these acts. The prevention of tuberculosis only requires the exercise of scrupulous care with regard to the expectoration, the removal to isolation hospitals of those who are unwilling, too ignorant, or unable because of weakness, to adopt proper precautions, and the disinfection of rooms, with their contents, which have been occupied by tubercular patients. There remain to be considered, aside from this prophylaxis as applicable to the human being, the measures necessary because of the possible transmission of the disease from animals, especially through the meat and milk of tubercular cows. But while this is a real danger, its importance has probably been greatly overestimated. It is now well known that tuberculosis very rarely exists at birth. It is never inherited, in the strict sense, and only in very exceptional instances does intra-uterine infection occur.

General prophylaxis has as yet scarcely touched upon many of the other infectious and probably, to some extent at least, preventable diseases. The venereal diseases have been ignored because the problem is so largely a social one. No preventive measures even promising in their character have been suggested for dealing with them. The prevalence of the puerperal diseases has been very largely reduced through individual prophylaxis at the time of childbirth.

The diarrhœal diseases of infancy are not as a rule properly to be regarded as communicable, but their prevalence has been greatly restricted through the work of health authorities in the sanitary control of milk and, to a less extent, of the water-supply. The reduction during recent years in the death-rate from diarrhœal diseases of children under two, which has taken place almost everywhere in this country, is almost phenomenal; and indirectly the reduced prevalence of these diseases has materially decreased others brought on by them — diseases of malnutrition, such as rickets, etc. The results which have thus been accomplished have been due almost entirely to increased medical knowledge and its intelligent application to preventive medicine.

Preventive medicine, however, in the truest, broadest, and best sense, includes not only this work in the general application of medical knowledge to restricting the prevalence of the infectious diseases in the community, but also the application of medical knowledge to the protection of the individual from disease of all kinds at every stage in life from birth to old age; and it is this individual prophylaxis which has received the least attention either from the medical profession or from the people. Here is a very large field for intelligent work. A moment's consideration shows at once the impossibility of formulating general rules, or of applying the same rules to all individuals, for it is a matter of common observation that individuals differ widely in their physical and mental characteristics, susceptibilities, and tendencies. The occurrence in different families of certain similar types of disease in successive generations is a matter of general observation; and the influences which are injurious at one period in life may be not only not harmful but beneficial at another. It is most unfortunate, from this point of view at least, that the family physician of former times is so generally disappearing. The ideal family physician knew thoroughly the family histories of his patients, their tendencies, susceptibilities, weaknesses; he watched every stage in the life of the child from birth; he knew where to restrain, where to encourage, and what to prohibit, where dangers to their physical well-being lay, and how to advise them for self-protection. In earlier days when the knowledge of disease was less extensive than at present, it was not within the power of the physician to advise as wisely as at present. It is well known now that disease as such is never inherited. It is too much the custom to think of disease as a definite entity, whereas it is really only an abnormal process. It is not possible to see or examine disease, as it has no existence as such, but in some instances the causes of disease may be studied, as is the case in the infectious diseases due to known micro-organisms. In these may be investigated the micro-organisms causing the disease and the changes in the organisms produced by the germs; so also may be studied the abnormal manifestations of life which these changes produce, those manifestations which are called the symptoms of disease. The so-called inherited diseases which are of an infectious nature are simply instances of infection during intra-uterine life, as tuberculosis and syphilis. The diseases of metabolism, such as gout, diabetes, adiposity, etc., are not instances of inherited disease, when they occur in different generations in the same family, as is frequently the case, but are the result of the transmission from parent to children of functionally inefficient organs, which break down under the demands laid upon them.

An absolutely efficient prophylaxis applied to the individual would permit the conduct of a physiological life from birth to its termination in a physiological death, occurring when the vital resistence with which the individual was endowed at birth was exhausted. With advancing medical knowledge and a higher civilization there should be a closer approximation to this condition in a larger and larger percentage of the population and a material prolongation of the mean life-time.

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Prevost, prĕ-vō', **Augustine**, English soldier: b. Geneva, Switzerland, about 1725; d. England 5 May 1786. He entered the army, served under Wolfe at Quebec as captain of the 60th regiment, and in 1778 captured the fort at Sunbury, Ga., for which service he was brevetted major-general. He commanded the forces which defeated Gen. John Ashe at Briar Creek in 1779, but failed in an attempt to capture Charlestown in that year. He distinguished himself by his successful defense of Savannah against the Americans in October 1779, and received full rank as major-general in recognition of his services.

Prévost, prā-vō, **Eugene Marcel**, French novelist: b. Paris, France, 1 May 1862. He was educated at the Polytechnic School in Paris and until 1891 was employed in a tobacco-factory at Lille. His conceptions are clever and well worked out, his style easy and usually graceful, but his later work, though brilliant, shows a tendency to the delineation of morbid emotional types. His first book, ‘Le Scorpion’ (1887), attracted great attention from its attack on the Jesuit system of education. His later works include: ‘Chouchette’ (1888); ‘La Cousine Laure’ (1890); ‘Lettres des Femmes’ (1892); ‘Nouvelles Lettres des Femmes’ (1893); ‘Demi-vierges’ (1894); ‘Le Moulin de Nazareth’ (1894); ‘Notre Compagne’ (1895); ‘Le Jardin secret’ (1897); ‘L'heureux Ménage’ (1901).

Prevost, prĕ-vō', **SIR George**, English soldier, son of Augustine Prevost (q.v.): b. New York 19 May 1767; d. London, England, 5 Jan. 1816. He entered the army in early youth, distinguished himself in the West Indies, was promoted major-general in 1805, and created a baronet later in the same year. In 1808 he was appointed lieutenant-governor of Nova Scotia and in the autumn of that year he conducted a division of troops to the West Indies where he participated in the capture of Martinique as second in command. He was made lieutenant-general in 1811, and appointed governor-in-chief of British North America. In the War of 1812 he rendered important service to his government, but his defeat at Plattsburg in 1814 forced him to abandon his attempt to invade New York and brought him under censure.

Prévost d'Exiles, prā-vō dĕg-zĕl, **Antoine François**, French author: b. Hesdin (Artois) 1 April 1697; d. near Chantilly 23 Nov. 1763. He was at first a Jesuit, then enlisted in the army, after a brief return to the order again turned soldier, and still later joined the Benedictines of St. Maur. Subsequently he lived in Holland and England, and in 1735 became almoner and secretary of the Prince de Conti. He founded ‘Le Pour et le Contre,’ a journal patterned after the ‘Spectator,’ which ran through 20 volumes (1733–40); translated Richardson and Hume's ‘History of England’; and wrote a ‘Histoire des Voyages’ (1747–80), and several works of fiction, including ‘Le Doyen de Killérine’ (1732–5). ‘Mémoires et Aventures d'un Homme de Qualité qui s'est Retiré du Monde’ (1728–56), which includes ‘Manon Lascaut,’ a story of some celebrity in French literature, frequently reprinted, and the basis of a drama (1851) by Barrière and Fournier, and ‘Contes, Aventures et Faits Singuliers’ (1764). A selection from his works appeared at Paris in 1810–16. Consult Harisse, ‘L'Abbé Prévost’ (1896); and the study by Schroeder.

Prévost-Paradol, prā-vō pā-rā-dōl, **Lucien Anatole**, French writer: b. Paris, France, 8 Aug. 1829; d. Washington, D. C., 11 Aug. 1870. He was educated at the Collège Bourbon and the Ecole Normal, was editor of ‘La Revue d'Histoire Universelle’ in 1854, and in 1855 accepted the chair of literature at the University of Aix, but resigned in 1856 to become editor of the Paris ‘Journal des Débats.’ As a journalist, his keen irony, his brilliant, forcible style, rendered him a formidable adversary. A believer in constitutional government he was opposed to Napoleon III. His articles were instrumental in recalling the French army from Mexico, but his contributions to the ‘Courrier du Dimanche’ caused the suppression of that journal in 1866. After the formation of the Ollivier ministry in 1870 he became reconciled to the empire and accepted the post of ambassador to the United States. His reception at Washington was very different from his expectations, public opinion being in sympathy with the Germans rather than the French in the Franco-Prussian troubles. The formal attitude of the Administration, and the trying conditions generally, preyed upon his mind and he committed suicide shortly after his arrival. His editorials are still considered models of journalistic style and his books include: ‘Du Rôle de la Famille dans l'Education’ (1857); ‘Quelques Pages d'Histoire Contemporaine’ (4 vols., 1862–6); ‘La France Nouvelle’ (1868).

Preyer, prī'ĕr, **Wilhelm Thierry**, German physiologist: b. Manchester, England, 4 July 1841; d. Wiesbaden, Germany, 15 July 1897. He was educated in the universities of Bonn, Berlin, Heidelberg, Vienna, and Paris, took degrees in both philosophy and medicine, and in 1869 was appointed professor of physiology at Jena. In 1888 he became privat-docent at Berlin. He has made valuable investigations in the fields of quantitative spectral analysis, the perception of sound and the precise qualities of the senses. Of his books the most famous is ‘Die Seele des Kindes’ (1881), and especially deserving of mention are: ‘Ueber Empfindungen’ (1867); ‘Ueber die Grenzen der Tonwahrnehmung’ (1876); ‘Elemente der allgemeinen Physiologie’ (1883); ‘Der Hypnotismus’ (1890).

Priam, prī'ạm, the last king of ancient Troy, was the son of Laomedon and Strymo or Placia. He was the 6th of the Trojan kings and reigned 40 years. His territory included Lesbos, Mysia, and the Hellespont. When a youth he marched with the Phrygians against the Amazons, and went as ambassador to the Thracians. After the death of his father he reigned in Troy. By his first wife, Arisbe, daughter of Merops, he had Æsacus. He afterward gave Arisbe to Hyrtacus, and married Hecuba, by whom he had, according to Homer, 19 children, among whom Hector, Alexander or Paris, Creusa, Laodice, Polyxena, Cassandra, Deiphobus, Helenus, Pammon, Polites, Antiphus, Hipponous, Polydorus, and Troilus were the most distinguished. By four concubines he also had 30 sons and four daughters. When he was extremely old the Greeks demanded of him the restoration of Helen, who had been carried away by Paris, and on his refusal to give her up they made war against Troy, took and destroyed the city, after a siege of 10 years, his son Hector having already fallen. According to later legends, when the Greeks entered the city he armed himself, to seek death in the midst of the enemy; but Hecuba prevailed upon him to take shelter at the altar of Zeus. Here he saw his son Polites fall by the hand of Pyrrhus; and, unable to contain himself, hurled his javelin at the youth, who dragged the old man by the hair from the altar and plunged a sword into his breast.

Priapus, prī-ā'pŭs, in Greek mythology, a field and garden god especially honored in Lampsacus, a town of Mysia, situated in a rich wine country. Aphrodite bore him to Dionysus when the latter was returning from India, though his father unwillingly acknowledged him on account of his ugliness. The first fruits of the crops were offered to him as the god of the fields, the protector of gardens, bees, goats, and sheep. Homer and Hesiod do not mention him and it was only in later times that he was honored with divine worship. He was represented with horns and goat's ears, and large phallus, having in his lap all kinds of fruits; in his hand he held a sickle, and usually a horn of plenty. His worship spread from Lampsacus to Greece and thence to Rome. He represents the productive power of nature and is the god of sensual pleasure.

Priber, prē-băr, **Christian,** French Jesuit in America. He came among the Cherokee Indians in 1736 and took up his residence with them in Great Tellico Town in what is now East Tennessee. Intending to make a dictionary and grammar of the Cherokee language he adopted the dress of the Indians to lessen their feeling of his being a stranger, meanwhile striving to civilize and convert them. His influence among the Cherokees grew to such an extent that they adopted a code of laws he prepared for them thereby exciting the distrust of the English government of South Carolina. Fearing French influence the English demanded Priber from the Indians, who refused to surrender him, and the safety of the English envoy was secured only by Priber's interference. But while traveling in Alabama in 1741 he was seized by the English authorities and cast into prison in Frederica, Georgia, where he soon died.

Pribilof, prē'bē-lŏf (sometimes called Pribylov, or Seal). a group of islands in Bering Sea, belonging to Alaska; about 200 miles north of the Aleutian Islands and 320 miles west of Bristol Bay. The largest islands of the group are Saint George and Saint Paul. The total area is about 180 square miles. This group is of great importance as here is the breeding place of the fur-seal. The winter home of the fur-seal has not (1904) been discovered; about May they come to Pribilof Islands, where the fog hangs over the land almost continuously. The islands were discovered the last of the 18th century by Gerassim Pribylof (or Pribyloff), a Russian, and first mate on the boat Saint George. He had been drifting about in the Bering Sea, looking for the breeding place of the fur-bearing seal, and at last he found the place. He took possession of the island (saw only one at first) for Russia, his country, and he named the island Saint George after his boat. Later the second island was discovered and called Saint Paul and the whole group was named after its discoverer. There are on the islands about 400 permanent residents.

Price, Julius Mendes, English traveler: b. London, England. He was educated in Brussels and at the Ecole des Beaux Arts, Paris; entered journalism and was a special artist-correspondent of the ‘Illustrated London News.’ In 1884–5 he served in the army with the Bechuanaland campaign in South Africa and has since engaged in various exploring expeditions in Siberia, Mongolia, China, western Australia, etc. He was with the Greek army in the Græco-Turkish war in 1897, was engaged in an expedition in the Northwest Territory, Canada, and the Klondike in 1898, and was in China in 1900–1. He has published: ‘From the Arctic Ocean to the Yellow Sea’ (1892); ‘The Land of Gold’ (1896); ‘From Euston to Klondike’ (1898); etc.

Price, Langford Lovell, English political economist: b. England 20 July 1862. He was educated at Trinity College, Oxford, was lecturer to the Toynbee Trust in 1886–7 and in 1895–6 was lecturer in statistics at University College in London. He was examiner at Victoria University in 1898 and in 1903 was called to that position at the University of Wales. He has published: ‘Industrial Peace’ (1887); ‘Money and its Relation to Prices’ (1896); ‘A Short History of English Commerce and Industry’ (1900); etc.

Price, Richard, British Unitarian clergyman and political economist: b. Tynton, Glamorganshire, Wales, 22 Feb. 1723; d. London 19 April 1791. In 1758 he became pastor of a Unitarian congregation at Hackney, where he continued as long as he lived. He published in 1758 ‘Review of the Principal Difficulties in Morals,’ which was followed by ‘Four Dissertations on the Importance of Christianity, the Nature of Historical Evidence, and Miracles, etc.’ (1767). In 1771 appeared his ‘Observations on Reversionary Payments and Annuities,’ succeeded by the celebrated ‘Northampton Mortality Tables,’ and other valuable works relating to life assurance and annuities. He also published ‘Appeal to the Public on the Subject of the National Debt’; and during the contest with the North American colonies, ‘Observations on the Nature of Civil Liberty' and the 'Justice and the Policy of the War with America' (1776). This work was widely circulated in this country, and Congress, through Franklin, expressed its desire to receive his assistance in regulating the national finances. When Pitt became prime-minister he consulted Price in his schemes for the reduction of the national debt, and the establishment of the sinking fund was by his recommendation. Consult Morgan, 'Memoirs of the Life of Richard Price' (1815).

Price, Sterling G. American soldier: b. Prince Edward County, Va., 11 Sept. 1809; d. Saint Louis, Mo., 29 Sept. 1869. He was educated at Hampden-Sidney College, studied law, removed to Chariton County, Mo., in 1831, and in 1840 was elected to the Missouri house of representatives, of which he was speaker until 1844 when he was elected to Congress. He resigned on the outbreak of the Mexican War and organized a cavalry regiment of which he was commissioned colonel. Under General Kearney he marched with his men from Fort Leavenworth to Santa Fé where he was left in charge, and upon being attacked by the Mexicans he repulsed them severely and completed the conquest of California. In 1847 he was promoted brigadier-general of volunteers, became military governor of Chihuahua, and in 1848 won a decisive victory over the Mexicans at Santa Cruz de Rosales. In 1853–7 he was governor of Missouri, and in 1861 presided over the convention called to decide the secession question. He was a «Conditional Union» man but later joined the Confederacy, and in 1861 was appointed major-general of State forces, participating under Gen. Ben McCulloch in the defeat of the Union forces at Wilson's Creek in August of that year. He then captured Lexington on the Missouri, but was forced to retreat before Frémont. He served under Van Dorn at Pea Ridge in 1862 and was promoted major-general in the Confederate army. He commanded one wing of Van Dorn's army at Corinth. He was defeated by Rosecrans at Iuka, Miss.; accompanied Beauregard in his retreat to Tupelo, and afterward serving in the Trans-Mississippi department, was there engaged in the unsuccessful attempt to capture Helena in 1863. In 1864 he succeeded in preventing General Steele's advance toward Red River, and later made a raid into Missouri. He was driven into southwestern Arkansas toward the close of the war and after the surrender he lived in Mexico until 1866. Consult Snead, 'The Fight for Missouri' (1886).

Price, Thomas Randolph, American educator: b. Richmond, Va., 18 March 1839; d. New York 7 May 1903. He was graduated from the University of Virginia in 1855, studied in Berlin and Kiel, and in 1861 returned home to enlist in the Confederate army in which he served through the war as a private and on the staff of Gen. Stuart. In 1867 he became professor of Latin and Greek at Randolph-Macon College, later being transferred to the Greek and English chair, and in 1876 was appointed to the chair of Greek and Hebrew in the University of Virginia. In 1882 he was called to Columbia University as professor of English language and literature and remained at the head of the department until his death. He published: 'The Teaching of the Mother-Tongue' (1877); 'Shakespeare's Verse Construction' (1889); edited 'Othello' in the Bankside Shakespeare (1890); etc.

Prich'ard, James Cowles, English ethnologist and physician: b. Ross, Herefordshire, 11 Feb. 1786; d. London 22 Dec. 1848. He studied medicine at Edinburgh, began practice at Bristol in 1810, and in 1814 became physician to the Bristol infirmary. In 1813 he published 'Researches into the Physical History of Mankind,' in one volume, but in the 3d edition (1849) extended to five; 'The Eastern Origin of the Celtic Nations' (1831); 'Natural History of Man,' which has been translated into both French and German (1843); 'Insanity and Other Disorders Affecting the Mind,' long a standard authority (1835); 'Different Forms of Insanity in relation to Jurisprudence.' In 1845 he was appointed one of the London commissioners of lunacy.

Prickly Ash, any of several prickly shrubs of the United States of the rue family (*Rutaceæ*) and genus *Xanthoxylum*, especially *X. clava-herculis*, whose aromatic and pungent bark is used in the southern States as a rustic remedy for toothache. In the south this bush is therefore known as toothache-tree and pepper-wood.

Prickly Heat. See Miliaria.

Prickly Pear, a genus (*Opuntia*) of American cactus. About 130 species have been recognized in the region they occupy from British Columbia through the western States, Central America and West Indies to southern South America. They are very variable in their specific characters, and the lines between species are very indistinctly marked. Some are very dwarf prostrate plants; others are tree-like in height and spread of top. They have club-shaped, cylindrical or flat spiny or hairy, fleshy stems, and except upon the youngest joints bear no leaves. These leaves drop off very soon. The flowers, which are borne near the upper parts of the joints or stems and on the most bristly parts, are solitary or in corymb-like panicles and are usually yellow and very showy. The fruit is a modified stem, the ovary being sunken in its apex. It varies with different species from dry to fleshy and succulent, in many species being edible. Prickly pears were in cultivation among the natives when America was discovered, and were introduced by the Spaniards to the Mediterranean region, and finally to Asia, South Africa, Australia, etc. In all these places they are now regarded as troublesome weeds, though in many they are valued for their fruit. In Sicily they are one of the chief crops, the peasants living mainly upon the fruit from July to November. Since some of the varieties will produce about nine tons of fruit to the acre upon land too rocky, thin or poor for other crops; since this production can be counted upon for a long series of years without any cultivation after the plants become established (in three years or less, usually); and since they are highly nutritious, their value is not over-estimated in climates adapted to their culture; namely, dry and frostless. They contain about 14 per cent of sugar and nearly 2 per cent of fat. A crop of nine tons per acre would, therefore, be equivalent to about 2,500 pounds of sugar.

In view of these statements it seems strange that attention has not been directed to improvement of varieties, etc. They have not been ranked with horticultural fruits, though they are of far more economic importance than many that are. In many sections they are used for stock feeding, especially in seasons of drought. The spines are generally rubbed or burned off, but cattle often eat them without this treatment, and frequently suffer death because the spines pierce their intestines. The plants are most used for fodder in the western States, Africa and Australia. In Tunis, dairymen are rarely without a plantation of prickly pear for their herd. The plants are also planted for ornamental purposes in gardens and greenhouses in many parts of the world not adapted to their cultivation; and in places adapted to them they are favorite hedge plants. The most esteemed species are probably the Indian fig (*O. ficus-indica*), the tuna (*O. tuna*), *O. engelmanni,* and *O. fulgida,* the first two being especially valued for the fruit, the last two for their fodder. *O. vulgaris* is a common species in the eastern States and is hardy as far north as Massachusetts.

Pride, Thomas, English Parliamentary officer: d. Nonsuch 23 Oct. 1658. Having been a drayman and a brewer, he began service in the civil war as ensign under the Earl of Essex, and was finally promoted colonel. As a soldier he won considerable distinction, being conspicuous at Preston (17–19 Aug. 1648), and commanding a brigade in the Scottish campaign. An extreme anti-Royalist, he was selected by the army to exclude the Royalist members from the House of Commons. (See PRIDE'S PURGE.) He was one of the judges of Charles I., whose death-warrant he signed. During the lord-protectorship of Cromwell, he was knighted and made a member of the newly organized House of Lords. On the Restoration, it was voted his body be exhumed and hanged with that of Cromwell on Tyburn gallows. Noble, author of ‘The Lives of the Regicides,’ says, however, that in Pride's case the sentence was not carried out.

Pride and Prejudice, a novel by Jane Austen, written in 1796, when the author was but 21, but not published till 1813. The theme is extremely simple: merely a history of the gradual union of two people, one restrained by unconquerable pride and the other blinded by prejudice; but in spite of little plot, the interest is sustained through the book.

Pride of India, Price of China, a tree (*Melia azedrach*), of the mahogany family, a native of Syria, Persia, and the north of India, and cultivated in different parts of the world as an ornamental tree. It grows to the height of 30 or 40 feet with a trunk of 20 inches diameter; but in open spaces it is spreading and not so high. Its leaves consist of smooth, pointed, dark green leaflets, arranged in pairs with an odd one at the end. The flowers, hanging in clusters at the ends of the branches, are of lilac color and agreeable perfume. They give place to bunches of berries about as large as cherries, and yellow when ripe. The fruit is sweetish, and edible, though generally supposed to be poisonous. In the cities of the Southern States where the tree was introduced by the elder Michaux, early in the 19th century and upon many of the plantations rows of Pride of India trees are very common, and in autumn the branches and the ground beneath are covered with their berries. A decoction of the bark of the root is administered as a cathartic and vermifuge. In large doses it is said to produce narcotic effects, and such appears to be the action of the ripe berries upon the robin redbreasts, which are very fond of them, and eat them until they become stupefied and fall to the ground. From this state, however, they soon recover.

Prideaux, prĭd'ō, **Humphrey,** English scholar and divine: b. Padstow, Cornwall, 2 May 1648; d. Norwich 1 Nov. 1724. He was graduated from Christ Church, Oxford, in 1672 and was appointed rector of Saint Clement's, Oxford, in 1679, prebend at Norwich in 1681, archdeacon of Suffolk in 1688, and in 1702 became dean of Norwich. He was a man of studious habits, a deep thinker, acquired a vast store of knowledge, and a wide reputation for judgment, integrity, and wisdom. His greatest work was entitled ‘The Connection of the History of the Old and New Testaments’ (4 vols., 1715–18). Among his other works are ‘Marmora Oxoniensia’ (1676); ‘Life of Mahomet’ (1697).

Prideaux, John, English soldier: b. Devonshire 1718; d. near Fort Niagara, N. Y., 19 July 1759. He entered the army in early youth, and attained the rank of brigadier-general in 1759. In that year he was given command of one of the four divisions which were sent to conquer Canada, and while Amherst, Wolfe, and Stanwix co-operated in the north, Prideaux attempted the reduction of Fort Niagara, one of the strongest fortresses in possession of the French. He landed before the fort on 7 July and opened an attack, repelled a sortie on 11 July and on the 19th prevented the landing of the French reinforcements sent by Frontenac, but was killed in the trenches on the same day by the premature bursting of a shell. His work was not without results, however, as the fort surrendered on the 24th.

Pride's Purge, the familiar name for the forcible exclusion of Royalist members from the House of Commons in 1648 by Colonel Thomas Pride (q.v.). Both houses of Parliament voted by large majorities to accept the terms offered by Charles I. The Council of Officers thereupon determined to expel members of the majority from the House of Commons, and on 6 Dec. 1648 Colonel Pride, acting under instructions from Fairfax, took his stand with a guard at the entrances to the Commons, forcibly prevented the entrance of about 90 members, and arrested above 40 others. The Independents were thus free to act in co-operation with the army. The few peers left in the Upper House made vain opposition to the measures of the decimated Commons, by which they were quite ignored, the Lower House passing a resolution that the Commons of England “have supreme power in this nation.” See ENGLAND, *History*.

Priene, prī-ĕ'nē, in ancient history, a city of Ionia at the mouth of the Gæson in early times, but because of the alluvial deposits of the Mæander finally lay several miles from the coast. One of the 12 cities in the Ionian League, Priene was conquered by Lydia, and on Crœsus' overthrow became the property of Persia. The great temple of Athene Polias, the scene of the festival called the Panionia, was here; a dedication upon it by Alexander the Great is now in the British Museum. The plan of the ancient city has been made plain by explorations made in 1895–9 under the management of the Royal Museum in Berlin. Consult Lenschau, 'De Rebus Prienensium' (1890).

Priessnitz, prēs'nĭts, **Vincenz,** German peasant, founder of the Kaltwasserkur, or system of hydropathy (q.v.): b. Gräfenberg, Austrian Silesia, 4 Oct. 1799; d. there 28 Nov. 1851. Having effected by the application of cold water a cure of a severe injury he had received, he subsequently employed it in local cases as a healing agent. Two English physicians, Sir John Floyer and Dr. Currie of Liverpool, had anticipated him in advocacy of the method, and a Silesian, Hahn, had published a book on it derived largely from a work by Floyer. But Priessnitz was the first to develop hydropathic practice. He established an institution at Gräfberg which was much frequented, among the guests being many physicians who came to study his claims. He wrote nothing himself, but many records of experiences of his cure, most of them favorable and many enthusiastic, were written by others. Consult the study by Selinger (1852); and Philo von Walde, 'Priessnitz als Begründer des Wasser- und Naturheilfahrens' (1897).

Priest, Josiah, American author: b. New York, about 1790; d. western New York, about 1850. He was an unschooled man, a harness-maker by trade; but published several books, some of which became very popular. Among them were: 'Wonders of Nature' (1826); 'View of the Millennium' (1828); 'Stories of the Revolution' (1836); 'American Antiquities' (1838); and 'Slavery in the Light of History and Scripture' (1843).

Priest, one who performs the sacred rites of any religion, especially the sacrificial rites, and who is thus a mediator between the Deity and men.

In primitive times the function of priesthood was inherent in the head of a family, the *pater familias;* but as states were organized priesthood on behalf of the people was assumed by the chief or king, or was exercised, under him, by a special order of men; but still the rites of domestic religion would continue to be performed by the head of the household. In early Greece and Rome when kings were banished and the power of the state came into the hands of elected magistrates the priestly office of the king, or his headship in religious affairs, was vested in the *archon basileus* as at Athens, or the *rex sacrorum* as at Rome; the term King (*basileus rex*) being retained after kingship had been done away, doubtless because of some religious scruple, lest the gods should resent the lowering of the appellation of the head of the state religion. The priests of the state religion were now appointed by the public authority, whether their functions were general or were restricted to the service of special gods in special temples.

In Rome there never was in pagan times anything like a priestly order or priestly caste or class, as the order of knights (*equites*) or patricians (*patricii nobiles*), nor was priesthood hereditary. In Greek states the priestly service in certain temples and places was restricted to certain families; for the rest, the priesthood was a function of the state. In Egypt the priesthood was a very close corporation, the members of which, with the king at their head, were the supreme arbiters of civil and even military as well as of religious affairs: the priesthood alone possessed whatever science existed of the mysteries of religion or of the secrets of statecraft, or the laws of nature.

In primitive Israel, as in other primitive societies, priesthood was the attribute of the father of the family: the priest by vocation, as a man set apart to minister on behalf of the people in their relations to the Deity, does not come into view till the Mosaic epoch; and the fully developed priestly system of Israel did not come into existence till the time of Solomon or even, perhaps, till after the return of the people from Babylon and the building of the second temple at Jerusalem by Zerubbabel in 520 B.C., nearly 500 years after Solomon's reign. Before the building of Solomon's Temple there were in Israel several temples or sanctuaries with oracles that were consulted to ascertain the will and pleasure of Jehovah, and with priests as their interpreters; and the priests and the Levites constituted a distinct order of society; but after the secession of northern Israel every devout king of Judah earnestly sought to suppress religious worship or sacrifice everywhere save in the central national Temple: this end was not achieved till after the return of the captives from Babylon. Henceforth the worship even of the true God elsewhere than in the Temple at Jerusalem was denounced as impious and little different from worship of false gods. The entire priestly order was massed in Jerusalem and its neighborhood; the priests were distributed into 24 classes each presided over by a chief priest, and each class of priests ministering in the Temple one week in rotation: over the whole priesthood presided the High Priest, believed to be always a lineal descendant of Aaron, the brother of Moses.

The ministers of the several religions mentioned, as well as those of Phœnicia, Babylon and other countries, are styled in English "priests": in Hebrew, Greek and Latin respectively the priest is *Kohen, hiereus* and *sacerdos.* But the English word priest, derived from the Greek *presbyteros,* an elder person, has not in itself any denotation of sacrifice or of priestly function but only of maturity of age.

In the Greek New Testament the priest of the Jewish law is always called *hiereus* and in the Latin Vulgate version *sacerdos,* never *presbyteros,* or *senior* (elder). On the other hand, neither in the Greek original nor in the Vulgate Latin version of it is *hiereus* or *sacerdos* ever said of the minister of the religion of Jesus Christ, but always *presbyteros* and *presbyter;* and in the authorized English version *presbyteros* is invariably rendered elder, never priest. Nevertheless, in the Book of Common Prayer of the Anglican Church and in that Church's Articles of Religion the word priest is everywhere employed instead of elder; but this "priest" of the Prayer Book is not *hiereus, sacerdos,* a sacrificing priest; for in the Articles the sacrificial function of the priest of the Catholic Church is classed with «blasphemous fables and dangerous deceits.» Hence for the Anglican Church, as for all the other Protestant Churches, the priest, presbyter or elder is not the minister of a sacrifice. It is different in the Catholic Church and in the numerous heretic and schismatic churches of the East. Those churches teach, with the Church of Rome, that in the Christian dispensation it is the chief office of the priest to offer sacrifice, namely, the eucharistic oblation, which is a perpetual representation of the offering made on Calvary. In the belief of those churches the mass is the self-same sacrifice which Christ offered — the victim the same, the priest the same: for the victim is Jesus Christ, his body and blood; and the priest is the incarnate Son of God in heaven, the High Priest, who is represented in the mystic offering by the priest who ministers at the altar.

It is worthy of mention that till the middle of the 3d century no extant writing of any of the fathers employs the Greek or the Latin word for priest (*hiereus, sacerdos*) to designate the *presbyteros*. In the Roman pontifical the order of the priesthood is called both *presbyteratus* and *sacerdotium*.

Priestley, prēst'lĭ, **Joseph**, English physicist and Unitarian divine: b. Fieldhead, Yorkshire, 13 March 1733; d. Northumberland, Pa., 6 Feb. 1804. After a secondary education he accepted an invitation to become Presbyterian minister of Needham Market, Suffolk, on an average salary of £30 a year. After three years he took charge of a congregation at Nantwich, Cheshire, to which he joined a school. Here his reputation increased, and in 1761 he was invited by the trustees of the Dissenting academy at Warrington to occupy the post of tutor of languages and belles-lettres under Dr. Aiken. A visit to London having introduced him to Drs. Franklin, Watson, and Price, he was encouraged to compose a 'History of Electricity,' which appeared in 1767. In the same year he became minister, at a salary of £100 a year, of the Mill Hill chapel at Leeds, where his religious opinions grew decidedly Unitarian. At Leeds his attention was first drawn to the properties of «fixed air» (carbonic acid gas); and about this time he completed his 'History and Present State of Discoveries relating to Vision, Light, and Colors.' In 1771 he agreed to accompany Captain Cook on his second voyage in the capacity of astronomer, but his appointment was cancelled, as the Board of Longitude objected to his theology.

After six years at Leeds he accepted an invitation from the Earl of Shelburne, afterward Marquis of Lansdowne, to reside with him as a companion in the nominal capacity of librarian. While forming a part of the establishment of this nobleman, he occupied himself in scientific pursuits, and in 1773 gave to the 'Philosophical Transactions' a paper on the different kinds of air, which obtained the prize of Copley's gold medal. On 1 Aug. 1774 he discovered oxygen or «dephlogisticated air,» as he called it, a result quickly followed by other important discoveries, such as nitrous gas, nitrous oxide gas, sulphurous oxide gas, fluoric acid gas, muriatic gas, and ammoniacal gas, etc. By these exploits he may be said to have been almost the first to render chemistry a precise science. In 1775 he published 'Examination of the Doctrine of Common Sense, as held by Drs. Reid, Beattie, and Oswald,' and soon after the treatise of Hartley. He had already declared himself a believer in the doctrine of philosophical necessity, and in a dissertation annexed to his edition of Hartley expressed some doubts of the immateriality of the sentient principle in man. This doctrine he still more forcibly supported in his 'Disquisitions on Matter and Spirit' (1777). Probably because of his «materialistic» views, the connection with Shelburne was dissolved in 1780, Priestley retaining an annuity by original agreement. He next removed to Birmingham, where he became once more minister of a non-conformist congregation, and occupied himself on his 'History of the Corruptions of Christianity' (1782), and 'History of the Early Opinions concerning Jesus Christ' (1786). With Erasmus Darwin, Watt, Boulton, Wedgwood, and other famous men he founded the now celebrated Lunar Society, which rendered Birmingham for the time of its existence almost the intellectual centre of England. His 'Familiar Letter to the Inhabitants of Birmingham' was written in support of the claims of Dissenters for a repeal of the test acts. The era of the French Revolution, whose principles Priestley vindicated, added to the usual animosity of theological dispute. The anniversary of the capture of the Bastille being celebrated at Birmingham, a mob assembled, and although Priestley was not present, burned his house, and nearly all his library, manuscripts, and apparatus. The outrage was countenanced by too many exercising both lay and clerical influence, and the legal compensation which he obtained fell short of his real losses by about £2,000. On 1 Aug. 1874, Birmingham made some amends for the wrong done to her greatest citizen, by the erection of a marble statue of him in front of the town-hall. On quitting Birmingham (1791) he succeeded his friend Price as preacher in the Gravel Pit Chapel, Hackney, where he remained some time in the cultivation of his scientific pursuits, until finally goaded by party enmity to seek an asylum in the United States, which he reached in 1794, and took up his residence at Northumberland, Pa. In America he dedicated his whole time to his accustomed pursuits. Some discourses of his led to the formation in Philadelphia of a Unitarian congregation, and he held private meetings in his own house. He was never naturalized; and, curiously enough, never learned to make change in United States coinage. Priestley was an ardent controversialist, chiefly in consequence of extreme simplicity and openness of character; but no man felt less animosity toward his opponents than he did, and many who entertained the strongest antipathy to his opinions were converted into friends by his gentleness and urbanity in personal intercourse. As a man of science he stands high in the field of invention and discovery, and to few has pneumatic chemistry been so much indebted. On his own admission his researches in his favorite science were superficial, and his great discoveries to a considerable extent accidental. But this should detract nothing from the honor due to the earnest pioneer. As a metaphysician his elucidation of Hartley's theory of association, his works upon philosophical necessity and upon materialism, will always insure attention. As a theologian Priestley, who followed his convictions wherever they led him, passed through all changes, from Calvinism to a Unitarian system in some measure his own; but to the last remained a zealous opposer of infidelity. Of his theological and controversial productions, those most generally esteemed are his 'Institutes of Natural and Revealed Religion' (1772–4), and 'Letters to a Philosophical Unbeliever' (1780–2). He also wrote many works of practical divinity. There is an edition of his 'Theological and Miscellaneous Works, with Memoirs and Correspondence' (1817–32).

Priests of the Mission. See LAZARISTS.

Priests of Saint John the Evangelist. See ORDERS, RELIGIOUS.

Prigg Case, The, in American history, a famous slave case tried in 1837. Edward Prigg caused a fugitive Maryland slave-woman to be returned to her mistress, in violation of a Pennsylvania statute forbidding the carrying of any negro out of the State in order to enslave him. The case was finally brought before the Supreme Court of the United States, where it was contended that the statute was unconstitutional since it conflicted with the National Fugitive Slave Act of 1793. The opinion was handed down that the national law must be carried out by national authorities alone.

Prim, Juan, hoo-än' prĕm, COUNT DE REUSS, MARQUIS DE LOS CASTILLEJOS, Spanish general and statesman: b. Reuss, Catalonia, 6 Dec. 1814; d. Madrid 30 Dec. 1870. Destined for the law, he entered the ranks of the volunteers in the cause of the infant queen Isabella on the outbreak of the civil war, which in 1833, followed the death of Ferdinand VII. At its close in 1839, Prim threw himself into politics, and when Queen Maria Christina quitted Spain, worked in behalf of the Progresista party against Espartero, who, 8 May 1841, had assumed the regency. In May 1843 he led the insurrectionist forces against Espartero, and upon the downfall of the Espartero ministry was rewarded by the queen by being created successively brigadier-general, Count de Reuss, and in 1843 governor of Madrid. Suspected later of conspiracy against the government in 1844, he was sentenced to six years' imprisonment but was released after six months, and made governor of Porto Rico. Distinguishing himself in the war against Morocco at the battle of Los Castillejos, 1 Jan. 1860, he was given the title of Marquis de los Castillejos. He commanded the Spanish expedition, which acting jointly with the French and English landed in Mexico early in 1862 to enforce claims of indemnity against that country, but withdrew his troops almost immediately. Again accused of conspiracy, he was banished in 1864, but headed an uprising in January 1866 against the government and was compelled to flee to England in 1867. From there he gave support to a revolution started in Spain that summer and in September suddenly appeared in Cadiz and fought against the government in the military revolution headed by Topete and Serrano. Upon the defeat of the government Serrano appointed Prim minister of war in his provisional government. He became head of the cabinet and procured the election of Amadeo, duke of Aosta, second son of the king of Italy, as king of Spain. He was shot by unknown assassins while driving through Madrid. Consult: F. Jimenez, 'Historia Militar y Politica de D. Juan Prim' (1860); Leonardson, 'Prim' (1901).

Primary Batteries. See BATTERY.

Primary Election. See ELECTIONS.

Primary Rocks, formerly applied by geologists to the earliest rocks, including particularly those owing their present state to igneous agency. Gneiss, various schists and granite were so regarded. At the present time Primary is used as equivalent to Palæozoic (q.v.).

Pri'mate, since the 4th century of the Christian Church, the title assumed by the bishop of the capital of a province, and hence equivalent to metropolitan or exarch. The Council of Chalcedon decreed that the primacy, or "first place before all," was to be accorded to the "archbishop of Old Rome." In Africa the title belonged to the bishop of Carthage. In other parts of Christendom an attempt was made to distinguish between primates and metropolitans as early as the 9th or 10th century, for one of the capitularies of the early French kings ordains that no metropolitan shall assume the title of primate unless he has a just claim to that honor; and in the 11th century the popes expressly reserved the title only for the leading metropolitans in different countries, and endeavored to subordinate the other metropolitans to them. The resistance to this arrangement was, however, so general and emphatic that the dignity of primate remained little more than a nominal one, entitling the holder of it merely to precedence on public occasions. In France the archbishop of Lyons was appointed primate of the Gauls by Gregory VII. in 1079, and the archbishop of Rouen is also primate of Normandy. In the German empire the archbishop of Salzburg was primate. In Hungary the archbishop of Gran is primate; in Bohemia that of Prague; in Spain that of Toledo. In Poland the primacy belonged to the see of Gnesen. None of these bishoprics any longer retain primatial rights of jurisdiction excepting that of Gran. The office belonged of right to the Papal legate, who was president of the senate and censor of the king. He governed the state during an interregnum, had a court, guards, and a marshal of the palace, and in general enjoyed the highest privileges. In the Church of England both the archbishops still retain the title of primate, the archbishop of Canterbury being distinguished as the primate of all England and the archbishop of York as the primate of England. In the Protestant Episcopal Church of Ireland the archbishop of Armagh is primate as formerly when the church was established.

Primates, the name given by Linnæus to his highest order or group of the *Mammalia,* which included the bats (*Cheiroptera*), the apes, monkeys, and lemurs (*Quadrumana*), and man (*Bimana*). By common consent of zoologists the bats have been removed, leaving the monkeys, lemurs and man as a fairly homogeneous group. Formerly the definition of this order was comparatively easy, but owing to numerous recent palæontological discoveries an almost unbroken series of forms between the lemurs and the *Insectivora* is now known, and the interrelationships between the former and the higher apes, and of the latter with one another and with man, have been shown to be more complex than was anticipated. Leaving out of account the prelemurine fossils, the order may be characterized as follows: There are always complete milk and permanent dentitions, the latter having the various kinds of teeth well differentiated and usually the following formula: incisors, $\frac{2}{2}$; canines, $\frac{1}{1}$; premolars, $\frac{2}{2}$ or $\frac{3}{3}$, and molars $\frac{3}{3}$ or $\frac{2}{2}$ (rarely). Occasionally there is the loss of an incisor, premolar or canine. The molars are of the simple quadritubercular grinding type, and the premolars are still simpler. In all cases the orbit is surrounded by a bony ring and frequently separated from the temporal fossa by a plate of bone. The clavicles are well developed, the radius and ulna and the tibia and fibula (except in one case) are never coalesced, the scaphoid and lunar bones of the wrist are distinct, and the pollex and hallux (except the latter in man) form opposable thumbs. With a few exceptions among the lemurs and marmosets, the digits are all terminated by flat nails. Except in isolated cases the stomach is always simple, there are two pectoral mammæ and the testes are contained in a scrotum. Concerning the subdivision of the order in suborders and families there are several opinions; but the customary recognition of the sub-order *Prosimiæ* or *Lemuroidea* for the lemurs and their allies, of *Quadrumana* for the monkeys, baboons and marmosets, and of *Anthropomorpha* for the apes and man will serve present purposes. Consult: Hartman, 'Anthropoid Apes' (1886); Forbes, 'Handbook of Primates' (1896–7).

Primaticcio, Francesco, frän-chĕs'kō prē-mā-tēt'chō, Italian painter: b. Bologna 1504; d. France 1570. He was a pupil of Innocenzo da Immola and Bagnacavallo, and began in 1525 to study under Giulio Romano. In connection with several of the pupils of the latter he painted the Palazzo del Tè, in Mantua, from Giulio's designs. Through the recommendation of Frederick, duke of Mantua, Primaticcio was engaged by Francis I. of France in 1531 to decorate the palace of Fontainebleau. To his influence were owing not only numerous paintings in fresco and works in stucco which the king caused to be executed, but several branches of painting, as, for instance, enamel painting, and designs for tapestry, were carried to greater perfection through his exertions. Francis sent him to Italy to purchase antique statues, and casts of famous works of art. On the death of Rosso, the royal painter, Primaticcio succeeded to his post, and Francis II. appointed him in 1559 superintendent of the royal buildings. He furnished the designs of several architectural works, among them of the tombs of Francis I. and Henry II. His works at Fontainebleau, however, gained him more reputation. His was a clever facile pencil, but he was the slave of mannerism and meretriciousness, and that fluent but artificial elegance which remained so long the characteristic of French art. His frescoes and stucco work have been almost all destroyed, we can only judge of their quality from engravings, and there are no oil-paintings which can with certainty be ascribed to him, even the authenticity of 'The Continence of Scipio' now in the Louvre is sometimes doubted.

Prime, Edward Dorr Griffin, American Presbyterian clergyman and religious journalist: b. Cambridge, N. Y., 2 Nov. 1814; d. New York 7 April 1891. He was graduated in 1832 from Union College, and from Princeton Theological Seminary at Princeton in 1838. He filled several pastorates, including that of the Eighty-sixth Street Presbyterian Church, New York, and contributed articles to the 'New York Observer' under the signature «Eusebius.» With his brother, S. I. Prime (q.v.), he edited the paper 1854–85, and continued to edit it a year longer after his brother's death. He published: 'Around the World' (1872); 'Forty Years in the Turkish Empire' (1875); 'Notes, Genealogical, Biographical, and Bibliographical of the Prime Family' (1888); etc.

Prime, Samuel Irenæus, American Presbyterian clergyman and editor: b. Ballston, N. Y., 4 Nov. 1812; d. Manchester, Vt., 18 July 1885. He was graduated from Williams College in 1829, entered the Princeton Theological Seminary and in 1833 was ordained in the ministry. He was in charge of pastorates at Ballston Springs, N. Y., 1833–5; at Matteawan, N. Y., 1835–40. In 1840 he became editor of the New York 'Observer' and continued as such until his death, with the exception of a period in 1849 when he was secretary to the American Bible Society, and another in 1850 when he edited the 'Presbyterian.' He was one of the founders of the Evangelical Alliance of America in 1866 and its corresponding secretary until 1884, was vice-president of the American Tract Society and was prominently connected with various religious and educational institutions. From 1854 he was a regular contributor to 'Harper's Magazine,' where his «Editor's Drawer» became famous, and in 1858 his literary earnings enabled him to purchase the 'Observer,' which he made the leading organ of his denomination. His 'Power of Prayer' (1858) reached a sale of 175,000 copies in United States and England and was translated into French, Dutch, and Tamil. Among his other books are: 'The Old White Meeting-House' (1845); 'Travels in Europe and the East' (1855); 'Letters from Switzerland' (1860); 'Kirwan' (1870); 'Irenæus Letters' (1st series, 1880; 2d series, 1885); etc.

Prime, William Cowper, American journalist: b. Cambridge, N. Y., 31 Oct. 1825; d. New York, 13 Feb. 1905. He was graduated from Princeton in 1843, studied law, was admitted to the bar in 1846 and engaged in law practice in New York in 1846–61. In 1861–9 he was editor-in-chief of the New York 'Journal of Commerce,' was 1st vice-president of the Metropolitan Museum of Art after 1874 and professor of the history of art at Princeton after 1884. He devoted much time to literature and was an authority on numismatics and Egyptian antiquities. Among his publications are: 'The Owl Letters'; 'The Old House by the River' (1853); 'Boat Life in Egypt and Nubia' (1857); 'Coins, Medals, and Seals' (1860); 'I Go A-Fishing' (1873); 'Holy Cross' (1877); 'Along New England Roads' (1892); 'Among the Northern Hills' (1895); etc.

Prime. See Canonical Hours.

Prime Minister, in most European governments, is a premier, secretary of state, or other officer of state, who at the summons of the sovereign has succeeded in forming an administration, of which he is the head, and which may be named after him. It may be assumed that those who accept office under him agree with his policy in the main. Though each member of the ministry administers his own department independently of his colleagues, all important departmental matters are submitted to him, the most important being brought before the whole ministry, and no appointment of moment is made or recommended to the crown without his knowledge and concurrence. His own patronage is very extensive. In forming an administration, he selects all those who are to fill the various offices, though the appointments are subject to the sovereign's approval. In England it is on his advice that as vacancies occur the archbishops, bishops and deans and the highest judges are appointed, and over one hundred crown livings are filled; and on his recommendation that the most envied temporal titles and honorable distinctions — peerages, baronetcies, and the Garter, for example — are conferred, and such high appointments as the lord-lieutenancy of Ireland, the viceroyalty of India, the principal ambassadorships and colonial governorships, and lord-lieutenancies of countries, are made by the crown. He is the leader of the House of Parliament, of which he is a member. Yet as prime minister he enjoys no legal precedence over his colleagues, his official existence being indeed not recognized by statute. In European governments the prime minister, or premier, is usually charged with the management of diplomatic affairs, and in this respect resembles the Secretary of State of the United States.

Prime Number, an integer indivisible by any number save itself and unity, that is, one which can not be factored; such numbers are 1, 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, etc. They occur very frequently among the lower numbers, and begin to be scarce among the higher thousands. The determination of the prime numbers has remained a mere matter of rejecting factorable numbers; this is done in a quasi-mechanical way by the table called Eratosthenes' sieve, upon which all the numbers to be tested are written at equal intervals and covered in succession by gridiron-like slips of paper, covering first all multiples of 2 (the even numbers may better be omitted at the start), then all multiples of 3, and so on. But even with the modern theory of numbers no rule has been laid down for the periodicity of the occurrence of the prime numbers. Gauss discovered in 1810 that the frequency of the prime numbers approximated to the value of the logarithm integral; Tchebycheff gave a formula based on the same integral for the determination of the number of prime numbers less than any given number; in a monograph dated 1859 Riemann gave an even more exact formula, and a very complicated one, also dependent on the integral li (x). The Theory of numbers has also shown that «every prime number is (in general in more than one way) a sum of four squares,» but this is equally true of other numbers, inasmuch as (1) every factorable number is the product of two prime numbers, and (2) the sum of four squares into the sum of four squares is always a sum of four squares. The theorem of Goldbach that «every even number is the sum of two prime numbers» seems at first glimpse a mere restatement of the definition of an even number. Factor tables have been made for all numbers between 1 and 10,000,000 in the attempt to codify the prime numbers; by reference to them it may be instantly discovered whether a given number is prime or not.

Primero, prĭ-mē'rō, or **Prime**, a card game very popular in England in the 16th century, but now obsolete. The same or a very similar game was played in Italy under the name *primièra*, and in France under the names *prime*, *ambigu*, etc. Primero belonged to the family of games of which the old post and pair and the more modern brag and poker are members.

Primitive Baptists. See BAPTISTS IN AMERICA.

Primitive Methodist Connections. See METHODISM.

Primogeniture, prĭ-mō-jĕn'ĭ-tūr, seniority of birth, and the right by law of the eldest son of a family (and of those who derive through him) to succeed, in cases of intestacy, to the father's real estate, to the absolute exclusion of the younger sons and the daughters. This rule, system, or right prevails in Great Britain: but, following the example of revolutionary France, most of the countries of continental Europe have abolished it. Several exceptions to the rule are allowed in the United Kingdom, but, these apart, whenever a man dies intestate leaving real estate, his eldest son is entitled to the whole of it, and the rest of the children not otherwise provided for out of the personalty are left without anything. If there is no male heir, the daughters succeed, not singly and in the order of seniority, but jointly. In the United States no distinction is made in the descent of estates to lineal descendants.

Primrose, a popular name for many garden and wild plants, among which the following are probably the best known: Evening primrose (*Œnothera biennis*, etc.); Arabian primrose (*Arnebia cornuta*); Cape primrose (*Streptocarpus* spp.); and various species of the genus *Primula*. This last consists of about 150 species of mostly perennial herbs with rosettes of leaves of various forms (especially under cultivation), and salver-shaped, generally showy, white, yellow, pink, lilac and purple flowers borne in clusters upon scapes. They are natives of the North Temperate zone, one species South American, one Javanese, and generally common in mountainous countries. About 40 are Himalayan; a dozen North American. They may be divided into five groups according to their uses as ornamental plants for which purpose they have long been popular. The auricula (q.v.) and the alpine primroses, neither of which are widely popular in America, the former because the climate is believed to be against them, the latter because alpine gardens have not become popular. Third, the yellow or purple-flowered out-door species, such as *P. imperialis* and *P. japonica*, which with winter mulching are grown in the Northern States; the polyanthus group, which contains the oxlip (*P. elatior*) and the cowslip (*P. officinalis*), very popular, fully hardy favorites blooming in early spring; and the greenhouse primroses, such as the Chinese (*P. sinensis*), *P. obconica* and *P. forbesi* (baby primrose), all of which are widely popular houseplants. Propagation is usually by seed, though varieties that do not come true to type may often be propagated by division or cuttings.

Seed should be sown soon after its collection, since it quickly deteriorates if allowed to become dry. In general, primroses succeed best in deep, well-drained, loose, rich loam not exposed to the glare of the sun. The polyanthus kinds may be grown in cold frames during the winter, set in beds in early spring, removed after flowering to shady moist situations for the summer, divided in the autumn and planted in cold frames again. The yellow-blossomed kinds are favorites with florists. The greenhouse kinds are sown under glass in early spring and kept growing steadily in flower pots of increasing sizes until the 6-inch size is reached in autumn when they should commence to blossom. The soil for them should be light, loose and rich both in plant food and humus. At the primrose shows there are often 200 to 300 distinct varieties on exhibition, mostly of *P. sinensis*, which has developed many remarkably beautiful forms attractive in foliage as well as flower.

Primrose Day, in England the anniversary of the death of Lord Beaconsfield (q.v.), 19 April 1881. Every member of the Primrose League (q.v.) wears a bunch of primroses on that day in token of sympathy with, and support of, the objects of the league.

Primrose League, an English political organization founded in 1883 by members of the so-called Fourth party (consisting of Lord Randolph Churchill and a few others) in memory of the Earl of Beaconsfield. The name was chosen in accordance with a mistaken notion that the primrose was Lord Beaconsfield's favorite flower. The league is one of the strongest bulwarks of the Unionist party. The members include knights, dames, and associates, and are divided into groups called habitations. In their propaganda they rely less on discussion, lectures, etc., than on the appeal to the social elements in human nature; and the rapid increase of membership is due mainly to the efforts of female members. In 1900 the league had 1,710,040 members on its roll, the number of habitations being 2,401.

Primula. See PRIMROSE.

Primum Mobile, prī'mŭm mŏb'ĭ-lē, in astronomy, the ninth or highest sphere of the heavens, whose centre is that of the world, and in comparison with which the world is but a point. This the ancients supposed to contain all other spheres within it, and to give motion to them, turning itself, and all of them, quite round in 24 hours. See ASTRONOMY.

Prince, Helen Choate Pratt, American novelist, grand-daughter of Rufus Choate (q.v.): b. Dorchester, Mass., 26 Nov. 1857. She was married in 1881 to C. A. Prince and is now (1904) residing in France. Her works are: 'The Story of Christine Rochefort' (1895); 'A Transatlantic Chatelaine' (1897); 'At the Sign of the Silver Crescent' (1898); 'The Strongest Master' (1903).

Prince, Le Baron Bradford, American lawyer and politician: b. Flushing, L. I., N. Y., 3 July 1840. He was graduated from Columbia College Law School in 1866; was member of the New York Assembly 1871–5, introducing the Constitutional amendments of 1874, and from 1876 to 1877 member of the State Senate. After this he became prominently identified with the development of New Mexico, politically and industrially. From 1878 to 1882 he was chief justice of that territory and its governor 1889–93. His writings include: 'E Pluribus Unum' (1868); 'Historical Sketches of New Mexico' (1881); 'A Nation, or a League' (1884); 'The Money Problem' (1896); etc.

Prince, Thomas, American clergyman and historian: b. Sandwich, Mass., 15 May 1687; d. Boston, 22 Oct. 1758. He graduated from Harvard in 1709, studied in England and was pastor of a church at Combs, Suffolk, England, 1711–16, then returned to Massachusetts accompanied by several of his congregation. On 1 Oct. 1718 he was ordained pastor of the Old South Church, as colleague of the Rev. Joseph Sewall. In 1727 appeared the first volume of his 'Annals of New England,' materials for which he had collected with great care while in England. It was approved by the legislature, but owing to the indifference of the public was never completed. He published also sermons, several works on phases of the early history of New England, and 'The New England Psalm-book Revised and Improved' (1758). He made a valuable collection of books by New England authors and MSS. connected with New England records; this was partially destroyed by the British in 1766, but the remainder was presented to the Boston Public Library in 1860. Prince was highly regarded for his erudition.

Prince, a title which means literally one who holds the first place. In ancient Rome the title of *princeps senatus* was given to the leading senator, being the one whose name came first in the list and who had the right to record his vote first. In modern times the title of *prince* (or *princess*) is given to all sovereigns generally, as well as to their sons and daughters and their nearest relations. In England the title is also applied, in strict heraldic language, as a mode of address to dukes, marquises, and earls, but it is not generally so used. In Germany there is a class of sovereigns, ranking next below the dukes, who bear the title of prince as a specific designation. The members of royal families are there called *Prinzen* instead of *Fürsten*, to distinguish them from the class to whom the latter title more peculiarly belongs. On the Continent there are ancient families not immediately connected with any reigning house who bear the title of prince. Formerly, in France, *duke* was a title superior to *prince*. In England the only case in which the title is a territorial one is that of the Prince of Wales. See NOBILITY.

Prince Albert Land, Canada, an Arctic island of the Franklin District, separated from the Mackenzie District by Coronation Gulf, Victoria, Dease, and the Dolphin and Union straits, along the Northwest Passage. Its southern and southeastern peninsulas are known respectively as Wollaston Land, and Victoria Land; Prince Albert Sound is a deep inlet on its eastern coast, and Collinson Inlet another on the north coast. It has not been fully explored.

Prince Edward Island, Canada, an insular province of the Dominion, in the southern part of the Gulf of Saint Lawrence, separated east to west from Cape Breton Island, Nova Scotia, and New Brunswick, by the curving Northumberland Strait, from 10 to 30 miles wide. The greatest length of Prince Edward Island on a curve is about 150 miles, breadth varying from

4 to 34 miles, area 2,133 square miles; it is the smallest province of the Dominion. The capital is Charlottetown (q.v.) which is connected by rail with all the principal points of the island. Other towns are Summerside, Georgetown, and Souris.

Topography, Physical Features, and Natural Resources.—The coast-line presents a remarkable succession of large bays and projecting headlands. Of the latter the most prominent are North Cape on the northwest, West Cape on the southwest, and East Cape on the northeast; the largest bays are those of Richmond on the northwest, Egmont and Bedeque on the southwest, Hillsborough on the south, and Cardigan on the east. The surface undulates gently, nowhere rising so high as to become mountainous, or sinking so low as to form a monotonous flat. The soil consists generally of a light reddish loam, sometimes approaching to a strong clay, but more frequently of a light and sandy texture. The prevailing rock is a Triassic reddish sandstone. The island is well watered by numerous streams and springs. At one time the whole island was densely covered with beech, maple, fir, and other trees, and it is still well wooded, only about two thirds of the area having been cleared. There are no minerals of any importance. The fisheries are valuable, in 1900 giving employment to 2,330 boats and 29 vessels of 750 tons manned by 4,895 men. The total value of the catch was $1,059,194: the most valuable item is the lobster, followed by the mackerel, cod, herring, and hake.

Climate.—The climate is much milder than that of the adjoining continent, and the air, generally free from the fogs which spread along the shores of Cape Breton and Nova Scotia, is remarkably salubrious. During the greater part of July, August, and September the thermometer during the hotter hours of the day seldom varies more than from 75° to 80° F.

Agriculture.—The island is eminently agricultural and pastoral. Of its total of 1,365,760 acres in 1900, 1,214,248 were occupied; 496,156 acres were in woodland and forest; 718,092 were improved; 536,175 were under crop; 178,072 were in pasture, and 3,845 in gardens and orchards. The principal products are wheat, barley, oats, beans, pease, potatoes, turnips, apples, etc. Good breeds of horses, cattle, sheep, and swine are reared, and dairy farming has become a thriving industry; large quantities of cream, butter, and cheese being manufactured.

Manufactures and Commerce.—The manufactures are chiefly confined to linen and flannels for domestic use; there are also several tanneries, boot and shoe factories, manufactures of tobacco, condensed milk, pork-packing establishments, and some ship-building. The exports of an annual average value of over $1,000,000, consist chiefly of agricultural produce, live stock and fish, the imports of about the same value are chiefly dry goods, iron, hardware, coal, etc.

Shipping and Communications.—In 1900 the shipping of the province was 155 sailing and 21 steamships, aggregating 14,251 tons, the tonnage of the steamers being 3;966. The Prince Edward Island Railroad, built by the Dominion government, connects the principal points of the island and has a length of 209 miles. Telephonic communication extends throughout the island, which is also traversed in all directions by good coach-roads.

Government.—The province is administered by a lieutenant-governor nominated by the crown, who appoints an executive council of 8 members, with a legislative assembly of 30 members, half elected on a property qualification, and half on a popular franchise. The province was admitted into the Dominion of Canada in 1873, and is represented in the Dominion House of Commons by five members.

Education and Religion.—Adopted in 1851 the free school system is administered by a government superintendent and council. In 1901, 20,779 pupils were enrolled in 475 schools conducted by 589 teachers, and $164,935 were expended for education. The membership of the principal religious denominations in 1901 was, Roman Catholics 45,796, Presbyterians 30,750, Methodists 13,402, Anglicans 5,976, Baptists 5,905.

History.—Sebastian Cabot is supposed to have sighted Prince Edward Island after discovering Newfoundland in 1497. Champlain gave it the name of Saint John and it was later included by the French in their vast and undefined territory of New France, and in 1663 was granted on a feudal tenure to a Sieur Doublet, a French naval officer. Little progress was made in settling the island till after the Peace of Utrecht in 1715, when its fertility attracted numbers of settlers from Cape Breton. It was taken by the British in 1745, restored by the Peace of Aix-la-Chapelle, retaken, and finally annexed to Britain in 1758. In 1873 it was admitted into the Dominion of Canada. Pop. (1891) 109,078; (1901) 103,259, chiefly native born of British origin, with 13,867 of French origin, and 1,604 of other nationalities. Consult: Campbell, 'History of Prince Edward Island' (1875); Dawson and Harrington, 'Geological Structure and Mineral Resources of Prince Edward Island' (1882-4).

Prince of India, a romance by Lew Wallace, published in 1893. The 'Prince of India' is the Wandering Jew.

Prince and the Pauper, The, a historical tale by Mark Twain (Samuel Langhorne Clemens) published in 1881. The plot hinges on the remarkable resemblance of a poor street boy to the young English prince, afterward Edward VI.

Prince Rupert's Drops, pieces of glass which have been cooled very suddenly from the melted state by having been dropped into water. They are called *larmes bataviques* (Dutch tears) by the French. The outside of the drop of melted glass is instantaneously solidified by the water, while the inside cools gradually, so that the outside shell is acted upon by very great stresses due to contraction of the internal portions when cooling. In fact the drop is kept in a state of excessive strain by stresses in unstable equilibrium; and if this equilibrium is destroyed by scratching the surface with a diamond, or breaking off the tip of the tail, the strained particles are violently released, and the mass is instantly pulverized. Heat is produced during the pulverization of the drop. This explanation applies to the falling out of the bottom of the very thick flask of unannealed blown glass called the "Bologna flask," when its surface is scratched. Glass articles—articles of any brittle material—ought to be cooled very slowly from the melted state. The process of slow cooling to which such articles are subjected is called annealing. To anneal glass it is placed in a large furnace which has nearly a red-heat at one end and a lower temperature than 100° C. at the other; after the glass has been passed very slowly from the heated to the cool end it is able to withstand sudden changes of temperature, etc., without fracture.

Prince of Wales, The, in England, the title given to the eldest son of the sovereign and heir apparent to the throne. The title is created and is not hereditary. It dates from the reign of Edward III. A statute of the order of the Garter, dated 1805, declares that the Prince of Wales shall, as soon as he receives this title, become a knight of the Garter. The arms of the Prince of Wales are the royal arms, with the addition of a label of three points argent, and any other addition that may be adopted by the different holders of the title.

Prince of Wales Island, the official name of Penang, an island of the Straits Settlement. See PENANG.

Princeites, prĭn'sīts. See AGAPOMONE; RELIGIOUS SECTS.

Prince's Feather, an annual plant (*Polygonum orientale*) of the buckwheat family, with erect spikes of dark-red flowers and leaves inclining to purple. It is a native of India, but has long been cultivated in gardens everywhere.

Prince's Island, or Ilha do Principe, ēl'yā dō prēn'sē-pĕ, a Portuguese island off the coast of West Africa; in the Bight of Biafra; nearly midway between Fernando Po and St. Thomas Islands. It is of volcanic character, rising in the south to 3,000 feet; fertile and well-watered, but of little importance since the extinction of the slave-trade ruined its sugar-plantations. Its fertility has gained it the name of the Garden of Africa. Cacao is the only important export. The population is concentrated mainly in São Antonio, a town with a fine harbor on the northeast coast. With the neighboring island of St. Thomé it constitutes a province under a governor.

Prince's Islands (ancient DEMONESI), a group of nine islets near the east end of the Sea of Marmora; about 10 miles southeast of Constantinople. Prinkipo is the largest of the group. They are a favorite summer resort of the Constantinople Greeks, and in old times were frequently a place of exile for those who were in disfavor at the Byzantine court. There are on the islands a Greek Church, seminary, monasteries, and a naval college. In 1894 an earthquake caused loss of life and destruction of property. Pop. estimated 10,500.

Prince's Metal, in metallurgy, a mixture of copper and zinc in imitation of gold.

Prince's Pine, or Pipses'sewa, a low North American evergreen health-plant (*Chimaphila umbellata*) of the wintergreen family. From its leaves are made a powder and a fluid extract, used in making a herb-medicine for scrofula, rheumatism, etc. Another species is the spotted wintergreen (*C. maculata*).

Princess. See NOBILITY; PRINCE.

Princess, The, a narrative blank verse poem by Alfred Tennyson, published in 1847, the theme being the position of woman. Besides the various exquisite lyrics intercalated between the cantos, the poem contains many of the poet's finest lines.

Prince'ton, Ill., city, county-seat of Bureau County; on the Chicago, B. & Q. railroad; about 100 miles west by south of Chicago. It was settled in 1830, incorporated in 1838, and in 1884 was chartered as a city. It is in an agricultural and coal mining region. Its industries are connected chiefly with farm products and the mining and shipping of coal, and the shipping of live stock. It has a number of well-built business blocks, a township high school, the Matson Public Library, and the high school library. The city owns and operates the electric light plant and the waterworks. Pop. (1890) 3,396; (1900) 4,023; (1910 est.) 4,000.

Princeton, Ind., city, county-seat of Gibson County; on the Southern and the Evansville & T. H. R.R.'s; about 27 miles north of Evansville. It was settled in 1804, incorporated as a town in 1814, and chartered as a city in 1884. Princeton is in an agricultural and coal mining region. The chief industrial establishments are the Southern Railroad shops, in which are 600 employees; the coal mines, 300 employees; oil wells, 100; lumber mills, 170; flour mills, 50; clock works, 60; handle factory, 10; and several smaller establishments. There are large lumber and brick yards. The city has 13 churches; and the educational institutions are a high school, public and parish schools, business college, and a Carnegie Public Library. The two banks have a combined capital of $200,000. The government is vested in a mayor, who holds office two years, and a council of six members. Pop. (1890) 3,076; (1900) 6,041; (1910) 6,448.

FRED R. EWING,
Editor 'Clarion News.'

Princeton, N. J., borough in Mercer County; on an elevation about three miles from the main line of the Pennsylvania railroad, with which it is connected by a branch line; 10 miles northeast of Trenton, and 50 miles southwest of New York city. It was settled in 1696, but remained a straggling hamlet for some years. The removal of the College of New Jersey from Newark to Princeton, in 1756, gave the place new life, and except when it was occupied by troops, and as a battle ground, it has ever since remained a staid college town. On 27 Aug. 1776, the first State Legislature of New Jersey met here. The 31st, the members elected William Livingston as governor of the State. Congress assembled here June 1783, and remained in session until November. The removal of Congress from Philadelphia was occasioned by the threatening attitude of discontented soldiers. While in session here, 31 Oct. 1783, the news arrived of the signing of the treaty of peace with England. Princeton has broad, well shaded streets, and its location on the ridge gives it a fine view over the surrounding country. The colonial architecture has been preserved to quite an extent. The place is noted as being the seat of Princeton University (q.v.). Other educational institutions are Princeton Theological Seminary (Presbyterian), the high school, and the libraries. Pop. (1910) 5,136.

Princeton (W. Va.), Engagement at. In the spring of 1862 Gen. Frémont, commanding a military department that included West Virginia, proposed to move from Monterey on Staunton, thence to the New River near Christianburg, his ultimate destination being Knoxville, Tenn. Gen. J. D. Cox, commanding on the Kanawha, was to co-operate by advancing from Gauley Bridge, in two columns, one by Fayette and Raleigh Court House over Flat Top Mountain to Princeton and «the narrows» of New River, the other by the turnpike to Lewisburg. Cox had four brigades; one was left to hold the lower Kanawha Valley; Col. George Crooks' was sent forward to Lewisburg; and Cox, with the two brigades of Cols. A. Moor and E. P. Scammon, about 2,000 men each, moved on the Fayette and Princeton route. Giles Court House and «the narrows» of New River were reached 7 May, and on the 16th his two brigades, after leaving a detachment at Princeton, were on the East River, and Crook had reached Lewisburg, on the other side of New River, all prepared to joint Frémont's main column at Christianburg. But «Stonewall» Jackson's appearance in the Shenandoah Valley sadly deranged Frémont's plans, and Cox was told to look out for himself. Meanwhile the Confederate brigades of Gens. Humphrey Marshall, Harry Heth, and J. S. Williams, all under command of Marshall, had been concentrated to protect the Virginia and Tennessee Railroad, and on the 16th Marshall, leaving Heth to hold the passes of New River, marched with about 2 500 men and three guns by the Wytheville road on Princeton, driving out the small detachment Cox had left there, after a stubborn resistance of six hours, continued until 10 P.M., and capturing the camp, with several tents, horses, and other things, including the headquarters correspondence. During the night Cox, with Moor's brigade, marched back from East River, ordering Scammon to follow, and at daylight of the 17th found Marshall withdrawing from the town and back to a wooded range of hills south and west of it. Cox advanced and attacked; and Marshall again fell back a mile, to a strong position covering the Wytheville and Wyoming roads, and waited for Heth to come up. Cox made some demonstrations, but seeing that Marshall held a steep wooded ridge, not easily accessible, and had a large force and some artillery, he waited until Scammon should come up, before making a serious attack. Scammon came up in the evening, closely pursued part way by Heth, and brought information that the Confederates were in great force; and Cox, realizing that his position at Princeton could be turned and his line of communication seized, retreated before daylight next morning to Flat Top Mountain, 25 miles from Princeton, a very strong position, and ordered Crook to halt at Lewisburg. Heth attacked Crook at Lewisburg on the 23d and was badly repulsed. (See LEWISBURG, BATTLE OF.) The Union loss at and around Princeton was 23 killed, 69 wounded, and 21 missing; the Confederate loss was much less. Consult: 'Official Records,' Vol. XII.; The Century Company's 'Battles and Leaders of the Civil War,' Vol. II.

E. A. CARMAN.

Princeton Theological Seminary, a Presbyterian seminary at Princeton, N. J. It was organized in 1812, and for a time the classes were held in the buildings of Princeton College (now Princeton University); in 1815 a tract of land was purchased for the Seminary, and a building erected. «The biblical criticism is conservative,» and «the theology taught is that type of Calvinism set forth in the Westminster Confession.» The courses include instruction in Old and New Testament theology, literature and history, homiletics, church history, pastoral theology, systematic theology, and Hebrew. The regular course is three years, a fourth year of graduate study is also provided for, and arrangement is made for «extra-curriculum» courses at the University. Students who are college graduates are admitted without examination; others must take examination for admission in full standing; students, however, on filing a certificate from the presbytery or ecclesiastical body under whose care they are studying for the ministry may without examination enroll in the classes and receive the certificate for completion of the course, but are not technically considered graduates of the Seminary. The degree of bachelor of divinity is conferred on students who have received the degree of bachelor of arts. The buildings include two library buildings, Stuart Hall, and three dormitories; the library numbers 86,000 volumes besides pamphlets. The grounds and buildings in 1910 were valued at about $628,000 and the productive funds amounted to $3,853,400. The students numbered 151 and the faculty 16.

Princeton University, located at Princeton, N. J. The first movement toward the establishment of the university was made in 1739 by the Presbyterian synod of Philadelphia, which appointed a committee to look into the matter, but this committee met with little success, and the project was laid aside for the time. In 1742 the synod was divided on account of a conflict growing out of the opinions of two factions in regard to the learning needed for admission to the ministry; one of these factions was the presbytery of New Brunswick, for the most part graduates of the Log College (founded by William Tennent in 1726); the other faction was the Presbytery of Philadelphia. After this division the presbytery of New Brunswick united with the presbytery of New York and others to form a new synod. Certain members of this synod, especially Dickinson, Pierson, Pemberton and Burr, turned their attention to the establishment of an institution on a more liberal basis than Log College, without denominational assistance or supervision. In 1746 they obtained a charter for the College of New Jersey. In the same year the Log College was closed by the death of its founder, and its leading men joined with the trustees of the new college. A second charter for the College of New Jersey was obtained in 1748; the scope of the college and the power of the trustees as stated in the two charters was essentially the same; the second charter increased the number of trustees and reaffirmed the liberality of the first instrument, opening the doors of the college alike to every religious denomination.

The college was opened in 1747 at Newark, N. J., in 1752 its location was fixed at Princeton, and in 1756 the building (Nassau Hall) was completed and instruction was begun there. The college exercises were interrupted during the Revolution by the presence of both armies, but only one Commencement was omitted; Nassau Hall was badly damaged, the library scattered and destroyed and the philosophical apparatus ruined. In 1783 when mutinous soldiers threatened the State House in Philadelphia, Congress removed to Nassau Hall, which was thus, for a time, the National capitol. A law department was established in 1846, but discontinued in 1852 on account of lack of funds; electives were introduced in 1870; the scientific school was established in 1873, and the graduate department in 1877. In October 1896, on the 150th anniversary, the name of Princeton University was adopted.

The organization of the University includes three departments: (1) the Academic Department; (2) the John C. Green School of Science; (3) the Graduate School. The Academic Department offers courses in the departments of philosophy, language and literature, mathematics and natural science. Most of the studies of the Freshman and Sophomore years are required; the elective system begins in the Junior year, and in the Senior year the range of electives is still wider. The degree of bachelor of arts is conferred in this department. The work of the John C. Green School of Science is in three main departments, the department of science, the department of civil engineering, and the department of electrical engineering, offering a graduate course of two years. The course in the department of science is again divided into two groups, the course in general science and the course in chemistry; the work of these two courses is the same in the first two years, the students making their election between the two at the close of the Sophomore year. Certain academic studies, including philosophy, history, English and political economy are included in the curriculum of this school. The degrees of bachelor of science, civil engineer and electrical engineer are conferred. The graduate school offers graduate courses in each of the departments of the academic course, and confers the degrees of master of arts and master of science for one year's graduate work, and doctor of philosophy and doctor of science for two years of graduate work under prescribed conditions. There are eight university fellowships, five college fellowships, and 113 scholarships of which the largest is the Mahlon Long scholarship of $10,000 founded in 1903 by G. W. Ely, of Columbia, Pa.

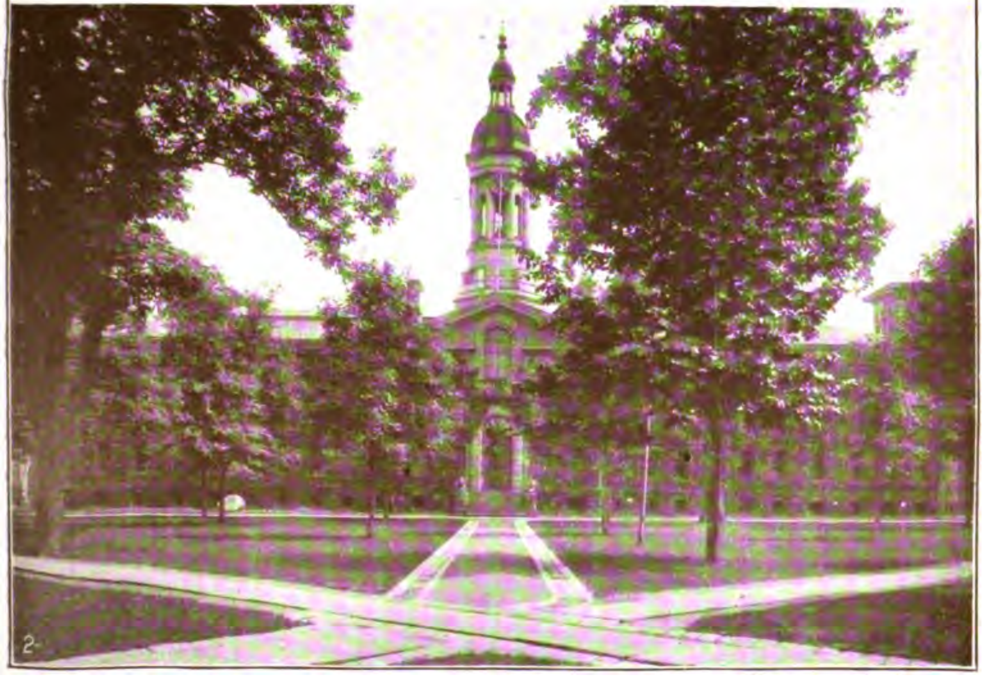
The present University Library consists of the Chancellor Green Library, built in 1872–3, and the New Library, erected 1896–7, united by a delivery room, 50 by 20 feet. The library collection in 1760 when the first catalogue was printed consisted of 1,300 volumes; in 1910 it numbered 268,000 volumes beside pamphlets; this includes several special collections and seminary libraries. The Garrett collection of Oriental manuscripts is in the library building, also the Garrett collection of American coins, and the Hutton collection of death masks. In addition there are four departmental libraries, astronomy, biology, botany, and geology and palæontology, selected from the general library and kept in other buildings near the corresponding laboratories; in 1910 these departmental libraries numbered 26,000 volumes. The Princeton Theological Seminary library is also open to students of the University. The University campus contains about 225 acres; among buildings beside the Library are Nassau Hall, the original building considerably remodeled, 11 dormitories, with the Halsted Observatory, Dickinson Hall, for the class room work of the Academic Department, the infirmary, the Marquand Chapel, Alexander Hall, and the old and new gymnasiums. Princeton has a leading part in intercollegiate athletics; besides the gymnasiums there are two athletic fields, the University Field, where all contests and games are held, and the Brokaw Field, for the benefit of those who are not members of the University teams. Secret societies are not allowed at Princeton, but the students maintain two literary societies founded before the Revolution, and other student organizations. The productive funds of the year 1910 amounted to $4,750,000 and the annual income was $2,196,000. The students of the year 1910 numbered 1,400, and the faculty 169. Woodrow Wilson, LL.D., inaugurated as president in 1902, resigned in 1910.

Principe, prēn'thē-pā, Philippines, subprovince of Tayabas, situated on the eastern coast of central Luzon, bounded on the north by Isabela and on the south by Nueva Ecija; length along the coast 64 miles; area 1,216 square miles, with dependent islands 1,218 square miles. The district is almost entirely mountainous; there are two main ranges, one near the coast, following the coast line, the other parallel with it, with narrow valleys between. Near the towns rice, corn, coffee, cotton, sugar, and vegetables are raised, but for home consumption only; there are a few simple mechanical industries, also for domestic use. The chief industry along the coast is fishing, and the fish are exported to the provinces to the south. Game is abundant in the mountains, and many of the inhabitants are largely engaged in hunting. There are no roads, few trails, and there is very little trade. In 1902 Principe was annexed to the province of Tayabas. Pop. 10,470.

Prindle, prĭn'd'l, **Cyrus**, American Methodist clergyman: b. Canaan, Conn., 11 April 1800; d. Cleveland, Ohio, 1 Dec. 1885. He was licensed to preach in 1821 and until his retirement in 1877 occupied various Methodist pulpits in New York, Vermont, Massachusetts, and Ohio. Opposed to the attitude of the Methodist Episcopal Church with regard to slavery, he became in 1843 the chief leader in the movement that resulted in the founding of the Wesleyan Methodist Church in America. He was an abolitionist from principle and when he had seen the work to which he and his followers were devoted, accomplished in the emancipation of the slaves, he returned to the Methodist Episcopal Church.

Pringle, prĭn'g'l, **Thomas**, Scottish poet: b. Blaiklaw, Roxburghshire, 5 Jan. 1789; d. London 5 Dec. 1834. He was educated at Edinburgh University and in 1811 became a copyist in the Register Office, Edinburgh. He began writing clever satire, and attracted the notice of Sir Walter Scott, who in 1817 gave him his notes for an article on the gypsies, which Pringle contributed to the 'Edinburgh Magazine,' started by himself and Cleghorn, and known after a rupture with the publisher as 'Blackwood's.' In 1820 with 24 others, he emigrated to South Africa, settling finally at Cape Town. Pringle worked hard to secure financial support for the colony by pamphleteering and started 'The South African Journal' and 'The South African Commercial Advertiser.' These were suppressed by the governor of the colony because of their liberal tendencies. In 1826 he returned to London and in 1827 became secretary to the Anti-Slavery Society. After seeing the triumph of his humani-

PRINCETON UNIVERSITY.



1. Stafford Little Hall. 2. Nassau Hall.

tarian endeavors in the abolition of slavery by England, in 1834, he died on the eve of returning to South Africa. His earlier poems were collected by him as ‘Ephemerides’ (1828); and the best of these, dealing with South Africa, were reprinted in ‘African Sketches,’ which included also the ‘Narrative’ of a residence in South Africa. These productions were characterized by vivid description and tender feeling. He is best known by his poem, ‘Afar in the Desert I Love to Ride.’ Pringle's ‘Poetical Works’ with a life were edited by Leitch Ritchie in 1839.

Prin'sep, Valentine Cameron, English artist: b. Calcutta, India, 14 Feb. 1838. He was elected R.A. in 1894 and is now professor of painting to the Royal Academy. He went to India to paint ‘The Declaration of the Queen as Empress’ in 1876 and the picture was exhibited in 1880. His other pictures include: ‘A Minuet’; ‘A Bientôt’; ‘The Linen Gatherers.’ Of his two plays, ‘Cousin Dick’ appeared at the Court Theatre, and ‘M. Le Duc’ at Saint James'. He has also written ‘Imperial India’; ‘An Artist's Journal’ and two novels.

Printing, the art of producing impressions from characters or figures on paper or any other substance. Printing is of comparatively modern origin, only 400 years having elapsed since the first book was issued from the press; yet the principles on which it was ultimately developed existed among the ancient Assyrian nations. Printing from movable types was probably practised in China as early as the 12th or 13th century, as there are Korean books printed from movable clay or wooden types in 1317. The great discovery was that of forming every letter or character of the alphabet separately, so as to be capable of rearrangement and forming in succession the pages of a work, thereby avoiding the labor of cutting new blocks of types for every page.

The city of Haarlem in Holland claims that Laurens Janszoon Coster there invented the art of printing in 1423, making use of movable types of wood and afterward of lead and tin; but no printed works of his can be identified. The claims of Johannes Gutenberg (q.v.) to this invention are more generally recognized. He without question was occupied in various experimental researches of a secret nature in Strasburg, and possessed in 1438 printing materials, a press, and as it appears movable types. No book, however, was brought out by their use until after Gutenberg had returned (which was about 1450) to his native city of Mainz. Here he associated himself with a wealthy citizen, Johann Faust, who, on learning the secrets of the art, entered into partnership with Gutenberg, and agreed to furnish funds for developing the process. They employed to assist them Peter Schöffer, a scribe whose previous occupation had been the copying of books, and who appears to have been a man of taste and genius, and well fitted to bring a new process of this sort favorably before the public. He has the credit of substituting metallic types cast in plaster molds in the place of those which Gutenberg had previously made by carving pieces of wood and metal, and of still further perfecting the art by the invention of punches in hard metal, by the use of which sharpness of outline could be given to the matrices in which the types were cast, and perfect uniformity be retained in the type by continuing to use the same punches for producing as many matrices as might be required. These inventors succeeded in printing a considerable number of books, the first of which known to have been printed with movable types were three editions of Donatus. Printing presses were in operation at Subiaco near Rome in 1465, and the types employed were more like those now called Roman than like the Gothic forms of the Germans, which with the characters imitating handwriting had up to this time alone been used. In 1469 printing was introduced into Milan and Venice; and the productions of the presses of John de Spira and Christopher Valdarfar of the latter city attained great fame for their perfection and beauty. Printing was introduced into Paris in 1470, and into London in 1474. (See CAXTON, WILLIAM.) Before the year 1500, it is stated, printing presses had been set up in 220 places in Europe, and a multitude of editions of the classical writers in their appropriate Greek and Latin characters were given to the world. A Greek grammar wholly in Greek types was printed in Milan in 1476. A Hebrew Bible was printed at Soncino in the duchy of Milan in 1488. Italic type was invented about the year 1500 by Aldus Manutius of Venice. From the 17th to the 19th century a great variety of ornamental type came into use, the styles differing from each other in the shapes of the letters, in the heaviness or lightness of the lines, and in the shading. Great ingenuity has been exercised in multiplying these varieties in so limited a field. The largest size of type for books is called great primer, and is seen in the largest old Bibles; it is now seldom used. English, which is the next lower size, is seen in church Bibles, in folios, and some quartos. Pica, small pica, long primer, and bourgeois are the sizes most in use. The succeeding varieties are brevier, minion, nonpareil, agate or ruby, pearl, diamond, and brilliant, the last being very rare, and the smallest type used in books. In the following list the different sizes are exhibited, each with its own name:

Great Primer, English, Pica,
Small. Pica, Long Primer, Bourgeois,
Brevier, Minion, Nonpareil, Agate, Pearl, Diamond, Brilliant.

Late in the 19th century the "point" system was adopted generally by printers. In this new arrangement the principal types are designated as follows:

Nonpareil	6	point
Minion	7	"
Brevier	8	"
Bourgeois	9	"
Long Primer	10	"
Small Pica	11	"
Pica	12	"

For handbills or posters special types are employed of extra large sizes. A complete assortment of one size is called a font or fount, and the "sorts" that make up an ordinary font of Roman type are as follows: 3 complete alphabets in capitals, small capitals, and small or "lower case" letters, making 78 characters; the double letters ff, fi, fl, ffi, ffl (each cast in a single piece on account of the kern or bend of the f not permitting it to stand separately against another f, an i, or an l), 5; the diphthongs Æ, Œ, Æ, Œ, æ, œ, 6; figures, 10; marks of punctuation, 6; the apostrophe, hyphen, parenthesis, and bracket, 4; 4 sizes of dashes, and braces in 5 pieces, 9; the characters &, *&*, $, £, ☞, 5; and the references *, †, ‡, §, ‖, ¶, 6; total characters, 129. Beside these, there are required for filling the blanks between words, at the ends of lines, etc., 4 sizes of spaces and 4 of quadrats (the former and the smallest of the latter being subdivisions of the em [m] or square of the size of the type, one equal to it, and the other two multiples of it), making altogether 137 sorts.

In presses the original invention was the hand press of 1450. Toward the end of the 18th century inventors began to devise presses to be moved by power. The first invention in this department is that of William Nicholson, patented in England in 1790. The types were placed around a revolving horizontal cylinder, and were inked by rolling against another cylinder revolving in contact with the first. For further information as to the development of the printing press see PRINTING PRESS. For a complete history of printing in the United States see AMERICAN PRINTING TRADE. See also COMPOSING MACHINE; STEREOTYPE; ELECTROTYPE, etc.

Printing in America. See AMERICAN PRINTING TRADE.

Printing Presses. In the early years of the 15th century, before the invention of movable metal types, crude religious pictures were printed from engraved blocks. These were at first single prints, and then folios and were bound in books. The most notable of the 21 known block-books was the 'Biblia Pauperium' (1420). This consisted of 40 woodcuts, 10 inches by 7½, of Biblical subjects, each with its legend in engraved Gothic characters. The sheets were printed on one side only, two pictures to a side, facing each other when bound. The press used was a development of the cheese or cider press common in all large mediæval households, and needed little change to adapt it to the uses of typography.

Gutenberg's press, upon which he printed his 'Bible' of 36 lines (1450?), his 'Bible' of 42 lines (1455?), and the 'Letters of Indulgence' of 1454, 1455, 1461, consisted of two upright timbers with connecting crosspieces at top and bottom, and with two intermediate cross timbers. The lower one was the support of the form of type. Through the upper passed a large wooden screw, the lower point of which rested on the centre of a wooden platen. After the form of type was fastened to its bed it was inked by hand inking-balls made of wool covered with soft leather. The sheet of paper, previously dampened, was then laid carefully upon the type, and the bed then moved laboriously by hand to its place. A wooden lever was thrust into its socket and the platen screwed down, held for a moment and then raised. The bed was drawn out and the printed sheet removed and hung up to dry. For 150 years this simple but effective form of the printing press continued in use, and the books thus printed by Fust and Schaeffer at Mainz, Jenson and the Aldi at Venice, Caxton at Westminster, Plantin at Antwerp, the Elzevirs at Leyden and at Amsterdam, and Bade and the Estiennes at Paris have brought their makers the highest fame.

First Improvements.— The first recorded improvements were those of William Janson Blaeuw, of Amsterdam, about 1620. He passed the spindle of the screw through a wooden block, which was guided in the wooden frame, and from it hung the platen. He also invented a device for rolling the bed in and out under the platen, and improved the hand lever for turning the screw. This press was widely used on the Continent, and in England and America, and on such a one Benjamin Franklin worked in London in 1725. One of these, that from the Watt printing house, is now preserved in the Patent Office in Washington. For nearly two centuries this sufficed for books of small editions and for the little-circulated small newspapers and gazettes of the 17th and 18th centuries. The Earl of Stanhope in 1798 had made a press with a cast iron frame and greater leverage, but it was so cumbersome and heavy that it came into no great use. Here and there others improved it. George Clymer, of Philadelphia, in 1816 substituted a combination of levers for the screws, and called his invention the Columbian press. He carried it to England and there in 1822 Peter Smith devised a toggle-joint, simple and effective, that replaced the screw and levers.

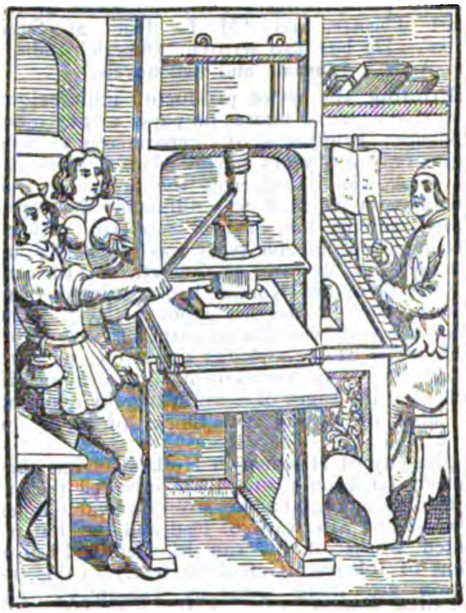
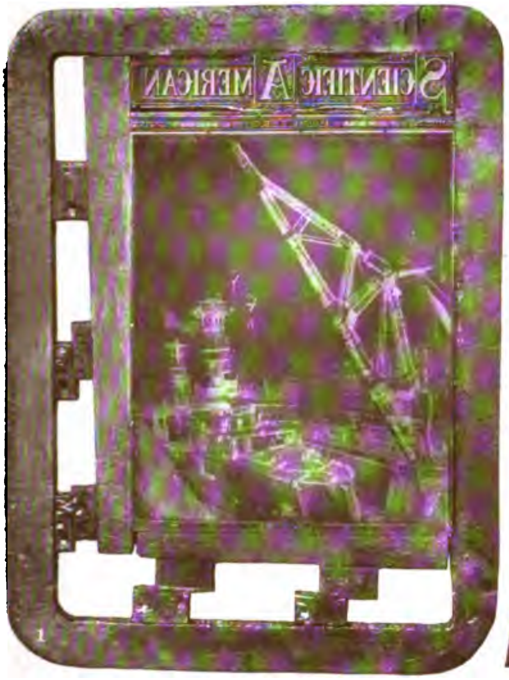
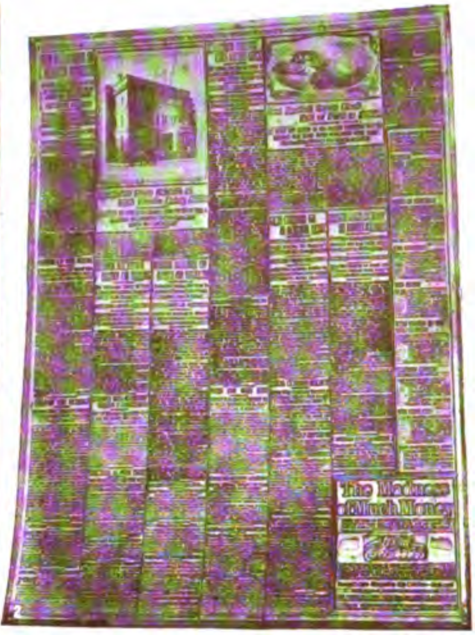


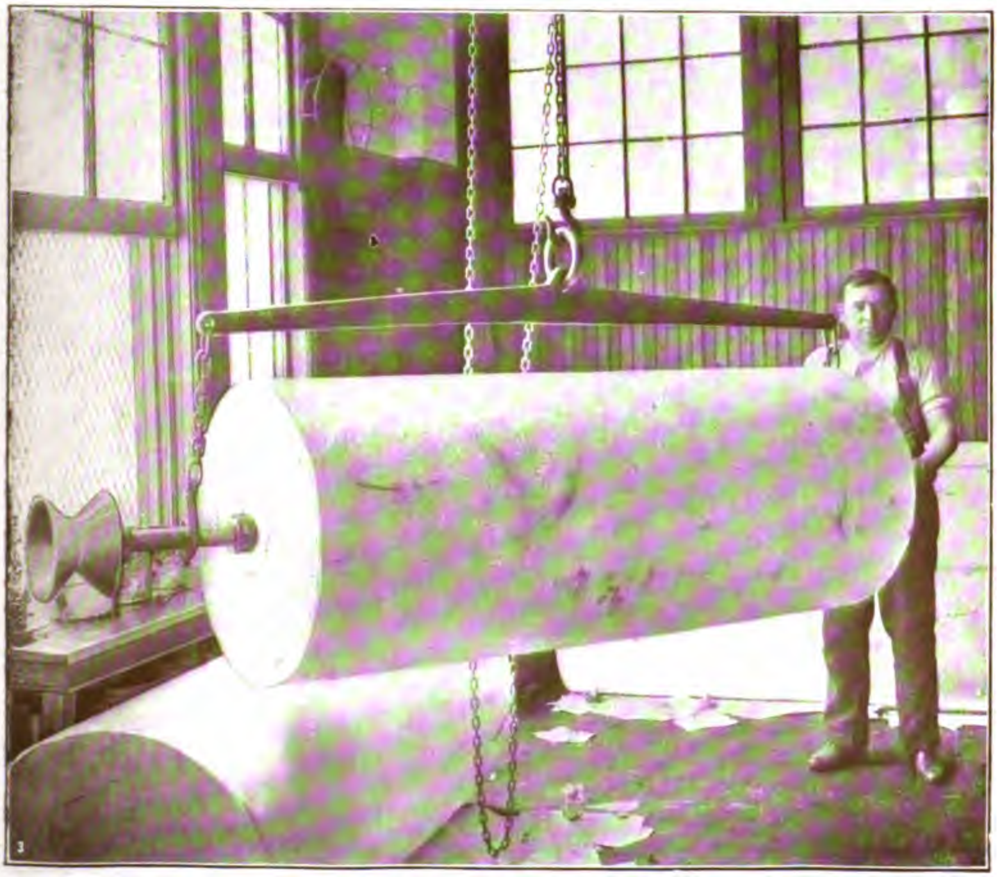
FIG. 1 — The Gutenberg Press.

The final development of the hand press came in 1827, when Samuel Rust, of New York, perfected the Washington press. The iron frame was lightened and strengthened, the toggle motion was improved, and a screw stop regulated the pressure. The bed was made to slide in and out on a track by turning a crank connected with two endless bands. A bent lever working in a toggle-joint forced the platen down and coiled springs raised it. To the end of the bed was attached the tympan, a wooden or steel frame over which a cloth was tightly stretched and carrying the blanket to modify the force of the impression. When the bed was run out this was raised to an obtuse angle. The paper was laid upon this and carefully fitted to adjust-

PRINTING.







1. A page form ready for electrotyping. 2. A stereotype plate of a newspaper page.
3. A roll of news paper ready for printing.

ing pins; the frisket, a thin frame holding a sheet of paper cut to the size of the form, was folded over the paper to protect it, to steady it and to raise the paper from the type after the impression. This press has been improved in construction, but in principle and form substantially the same press is widely used to-day in the United States as a proof press and for the special work for which it is fitted. Its capacity is about 250 sheets an hour printed on one side. Alike in principle and construction, though differing in detail of depressing and raising the platen, is the Albion hand press as widely used in Great Britain.

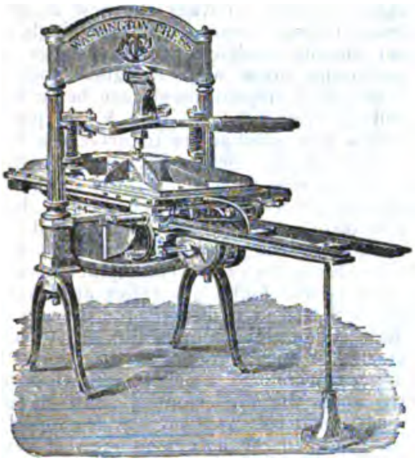


Fig. 2—Washington Hand Press.

The operation of the hand press when type, press, ink and paper had been prepared necessitated these eleven processes: The form was inked by hand; the paper was fitted to its place on the tympan; the frisket was folded over it to hold it; the tympan was folded down over the form; the bed was run under the platen by turning the crank; the platen was forced down by the workman's power applied to the lever; released, it was raised up by the springs; the bed was rolled out by a reverse motion of the crank; the tympan was raised; the frisket opened, and the printed sheet removed. Modern invention has sought to reduce all these to a single automatic process operated by mechanical power. Necessity divided the course of invention into three lines, the small job press and the large book and newspaper press soon widely diverging in type and construction to secure fine printing in one and the greatest speed in the other.

Bed-and-Platen Presses.— The development of the bed-and-platen power press for fine book work and illustrations reached its highest state in the Adams press, invented and patented by Isaac Adams, of Boston, in 1830 and 1836, and improved in many ways by R. Hoe & Co. since that firm acquired his business and patents in 1858. Over 1,000 have been manufactured, and it is still extensively used all over the world. Adams, after a few experiments with a timber frame, built his presses of iron and fixed the platen immovably in the frame. The form was placed on an iron bed beneath, as in a hand press, and this bed was raised against the fixed platen and lowered by a system of cams straightening a toggle-joint. The ink fountain was placed at one end of the press, and the ink rollers in a movable frisket-frame passed over the face of the type and back while the bed was down. The sheets of paper were fed to grippers on the frisket which carried them over the form, and after the impression was taken the sheets passed forward on tapes to a sheet-flier, which delivered them to the fly-board. The speed of the larger sizes of the Adams press is 1,000 sheets an hour.

The most successful press designed for small job work substituted for the hand lever and crank a rotary power wheel which could be driven by a treadle by the foot of the operator, or by belt and shafting. The bed was set in a perpendicular frame, and the form was clamped to it. To the bed frame near the bottom was jointed the frame that held the platen. This opened to an angle of about 45 degrees. A crank rod fastened to the wheel brought the platen up to the type form and back at every revolution. On the platen by adjustable pins or quads the position of the paper was exactly fixed. Two thin steel frisket rods automatically folded over the margin of the paper as the platen rose. Above the bed of the press, and at an angle of from 225 to 270 degrees, was set a steel inking-disk, about the size of the bed, that slowly revolved, while at every revolution of the driving wheel a pair of ink rollers descended from the inking-disk over the form as the platen fell away, and back to the inking-disk as the platen rose to the form again. This automatic inking was even and uniform. This press prints over 1,000 impressions an hour, cards, letter-heads, hand-bills and the like. The labor needed is that of a boy or girl to feed and take off the sheets one by one. Many varieties are made, with varying excellence of detail. The Gordon press here illustrated is typical and widely used. The capacity is about 1,000 sheets an hour. The latest improvement is embodied in the Harris automatic press which has an automatic feeding device and a capacity for small work of 5,000 impressions an hour.

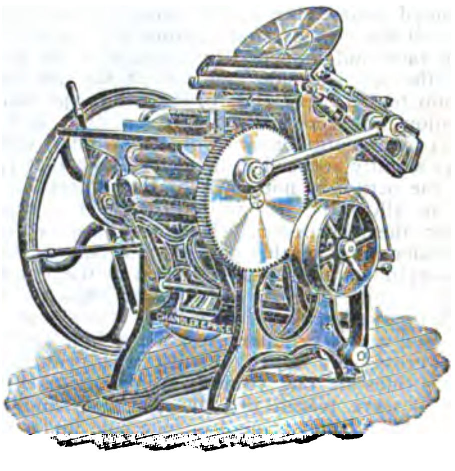


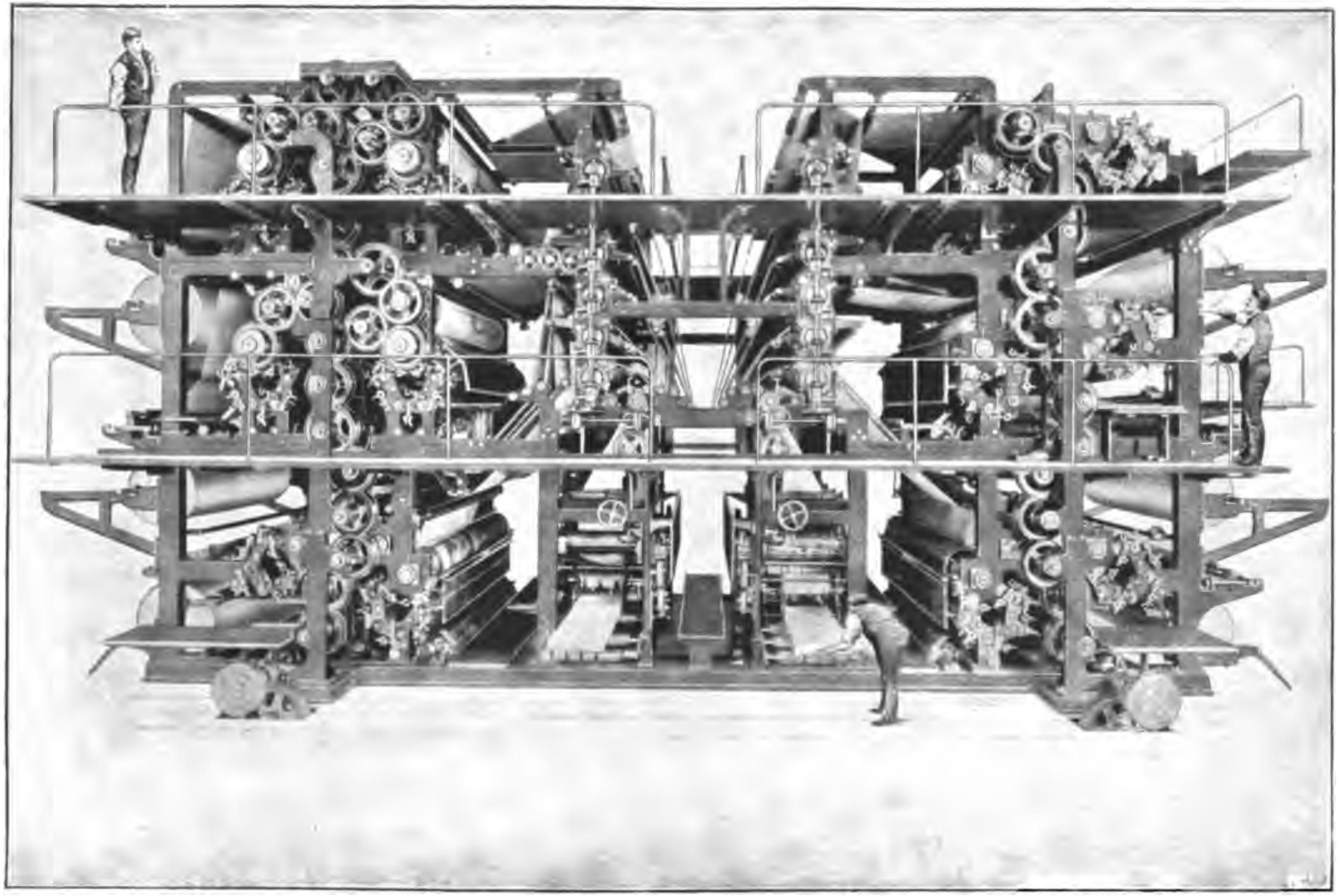
Fig. 3—Gordon Jobber.

Cylinder Presses.— The basic principle of the cylinder press — a flat type form passed under an impression cylinder — is as old as Gutenburg's time, when from crude machines of this type copper-plate engravings were struck off; but no practical development of it was made until the beginning of the 19th century. So many patents have been issued since then for various devices to secure excellence or economy of operation that it is possible to note only the most striking and most successful. The first printer to work out a practical cylinder press was Frederick König, a Saxon by birth, who removed to England in 1806. He associated with him James Bensley, a London printer, and a machinist, a fellow countryman, Andrew Bauer. The product of their labors was a press which they put in operation in London in 1812. The form of type was placed on a flat bed, which was carried under an impression cylinder that had a three-fold motion. On the first third the sheet was fed at the top upon the tympan and gripped by the frisket, on the second part of the revolution the sheet received the impression and was removed by hand; and on the third the empty tympan came up to receive another sheet. The most efficient device which they invented to roll the bed holding the type form to and fro was this: A long shaft turned by gearing from the outside of the frame carried a pinion on its inner end; the shaft had in its length a universal joint that allowed for an up and down motion of the pinion as it revolved. Underneath and fastened to the bed was a rack, or row of teeth, with a crescent-shaped segment of metal and pins, or studs, at each end. To the outer end of the shaft was attached the wheel connecting with impression cylinder; this wheel, when set in motion, revolved the pinion and moved the bed by means of the teeth in the rack. When the bed reached the end of its appointed course, the pinion turned around over one of the pins or studs against the segment in the rack and immediately re-engaged the teeth on the opposite side and carried the bed back again to the other end, where the reciprocating motion was repeated. König followed this in 1814 by a continuously revolving cylinder, which was slightly reduced in diameter along that part of the periphery not used for the impression so as to allow the bed to return under it freely after the impression. He made also a two-cylinder press of this pattern, and two of these two-cylinder presses were set up in the London *Times* office in that year. Their capacity was 800 impressions an hour. This same year he devised a two-cylinder press — the first perfecting press,— by which a sheet was printed on both sides at one continuous operation. The forms were placed one at each end, and the sheet after being printed on one side under one cylinder was by tapes carried over a registering roller to the second cylinder for printing on the reverse side. This machine Applegarth and Cowper, by improvement, made very efficient. Every year showed patents on improvements, but the next of great value was that of Napier in 1828 and 1830. He discarded the tapes for the conveyance of the sheets and substituted «grippers» or «fingers» to clasp the sheets to the cylinder for the impression, and for delivering them after printing. He also made the impression cylinders of small size to make two or more revolutions to each sheet printed, and devised the toggle for raising the cylinder to allow the form to run back without touching.

The pioneers in introducing these new models into the United States were R. Hoe & Co., who had been for some time manufacturing bed-and-platen presses. Robert Hoe sent Sereno Newton (later to be a partner in the house) to England in 1832 to study the new inventions and devise improvements. The Hoe single small cylinder, double small cylinder and large cylinder perfecting press were designed and built, and with added improvements are being manufactured by them to-day. Hoe & Co. patented an entirely new mechanism to drive the bed in 1847. Two racks facing each other on different planes and separated by the diameter of the driving wheel were attached to a hanger fastened on the lower side of the bed. The driving wheel was on a horizontal shaft and movable sideways, so as to engage first one, then the other, of the racks. A roller at either end entering a recess in a disk on the driving shaft in a half revolution brought the bed to a stop and started it in the opposite direction. This was a new principle; a crank action operating directly upon the bed from a shaft having a fixed centre. It has been greatly developed, and now the type bed can be driven at great velocity and reversed without shock or vibration. A press with a bed measuring 48 x 65 inches can be run at a speed of 1,800 impressions an hour.

Still another invention came from abroad to be further developed here. A Frenchman named Dutarte in 1852 patented the stop-cylinder press which Hoe & Co. introduced in the country in the following year. Many improvements have been added to it by many inventors, until from it can be turned off the finest letter-press and cut work known to the printer's art. It is regarded the most perfect flat-bed printing press yet designed. A press with a bed 36 x 54 inches is capable of 1,000 to 1,500 impressions an hour, while the latest one built has a bed 45 x 62 inches and a speed of 1,700 impressions an hour. The press of to-day carries the form on a traveling iron bed moving on friction rollers of hardened steel and driven back and forward by a simple crank motion, stopping and starting without noise or shock. The cylinder is stopped by a cam motion, pending the backward travel of the bed, and during the wait the sheet is fed down against the guide; the grippers close on it before the cylinder starts, thus securing accuracy of register. The sheet, after the impression, is transferred to a skeleton cylinder, which receives it with grippers and delivers it over fine cords upon the sheet fliers, which deposit it on the table. From four to six inking rollers distribute the ink, partly from a vibrating polished steel inking cylinder and partly from a flat inking table at the end of the traveling bed.

Similar presses, with varying individual devices for securing special points of efficiency and of varying degrees of merit have also been made and widely distributed by such American press makers as A. B. Taylor, A. Campbell, C. B. Cottrell, C. Potter, Jr., Walter Scott, and the Goss, Huber, Miehle, Whitlock, Coy, and Duplex companies. Excellence, skill and accuracy in mechanical construction and ready resource of invention have maintained the supremacy of the American presses, over the foreign trade.



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THE LARGEST PRINTING PRESS IN THE WORLD.

THE DOUBLE SEXTUPLE FOR NEWSPAPER WORK.

Newspaper Presses.— The demand for faster presses of greater capacity grew enormously with the years of the 19th century, and invention kept pace. The greatest step forward was taken when Richard M. Hoe, of the firm of R. Hoe & Co., of New York, in 1845–6 took out patents for the Hoe Type-Revolving Machine, the first of which was put at work in the Philadelphia *Public Ledger* office in 1846. He had put into effect the basic idea of fastening the type to the main cylinder, while smaller cylinders carried the sheets of paper to receive the impression. Hoe designed an apparatus for fastening the columns of type in a form on a large central cylinder in a horizontal position, each page in its own cast iron bed. «V»-shaped column rules tapering to the base, with a special arrangement for locking up the forms, held the type firmly in place with the surface forming a true circle. The cylinder could be revolved at any speed without the type dropping out. An automatic inking apparatus carried the main ink-well beneath the cylinder, with distributing rollers between the impression cylinders. This first machine was built with four impression cylinders touching the type cylinder so that two were on each side and one as far above the other as possible. The framework of the machine bore four feed tables. At each a boy fed the sheets of paper to the automatic grippers, operated by cams, on the impression cylinders, which carried them around against the revolving forms of the central type cylinder. The printed sheet was conducted out by tapes under the feed board, and the patented sheet-flier, with its long wooden fingers fastened to the shaft and operated likewise by cam and springs, piled them upon the delivery tables. Upon this machine, with 2,000 revolutions an hour, 8,000 sheets were struck off printed on one side. The capacity of the machine was found to be greatly in excess of this, and the number of impression cylinders and accessories was increased to ten, giving the machine a product of 20,000 sheets an hour. The impetus given to the newspaper business was tremendous. Circulations that had been limited to the capacity of the old bed-and-cylinder press were rapidly increased twenty-fold. Many new papers were started. This press maintained its supremacy for 20 years, and 175 were built. In 1848 the first sent abroad was set up in the office of 'La Patrie' in Paris, but the stamp duty of the second empire soon effectively checked all French newspaper enterprise. Eight years later, however, Edward Lloyd, of 'Lloyd's Weekly' in London, saw this American press in the office of 'La Patrie' and ordered a six-cylinder press, which was erected in his office, Salisbury Square, Fleet Street, in 1859. John Walter, the proprietor of the London *Times,* having seen it in operation, ordered two ten-cylinder presses to replace their unique Applegarth vertical cylinder machines. Orders from almost all the leading newspapers of the United Kingdom followed. The next great step was taken in an allied trade when after various experiments was perfected the process of making curved stereotype plates by the use of flexible paper matrices. A simple adaptation of the bed of the type-revolving machine provided for the clamping of stereotype plates on the cylinder in place of the type forms. The forms could now be duplicated. The larger papers such as the New York *Herald,* the London *Daily Telegraph* and the London *Standard* each kept five presses in constant operation as circulation increased.

Web Presses.— There remained yet another step before the increasing requirements of speed could be met. It was taken when William Bullock, an American, of Philadelphia, invented in 1865 the first printing press to print from a continuous web or roll of paper. Thirty years before, Sir Rowland Hill had suggested the possibilities of such a machine based on those that printed cotton cloth from engraved cylinders. But no practical working out of the problem in its details was offered. The Bullock press consisted of two plate cylinders and two impression cylinders, the second of which was made very large to lessen the offset from the first printed side of the paper. The stereotype plates were short of filling the whole circumference of the form cylinders, because the sheets were cut before printing by knives set in the cylinders. This was the radical fault of the press. The sheets were then carried through the press by tapes and fingers, and delivered by a series of automatic metal nippers on endless leather belts, placed at such a distance apart as to grasp each sheet successively as it came from the last printing cylinders. The Bullock press was perfected and came into considerable use. The New York *Sun* was the first newspaper to make use of them, and the New York *Herald* soon followed.

In 1868 the London *Times* had gone so far with its own experiments in constructing a rotary perfecting press that it set up the «Walter» press in its office. This had a capacity of 12,000 sheets an hour. It was similar in construction to the Bullock press, except that the cylinders were of uniform size and placed one above the other. The sheets, however, were severed after printing, brought up by tapes and carried to a sheet-flier, which moved back and forth and «flirted» the sheets alternately to boys on either side. This press was equipped with dampening cylinders containing sponges filled with water, and required a very strong and expensive paper. This press was also adopted by the London *Daily News* and the New York *Times,* but has now entirely gone out of use.

A recent invention in cylinder presses to satisfy the demands of small daily papers throughout the country for speed and economy is the Duplex press. It is a flat-bed web-perfecting press, and prints directly from the type form, with a capacity of from five to six thousand per hour of either 4-, 6-, 8-, 10-, or 12-page papers. Another adaptation for job work is the Coy rotary job press; this is simple in construction, and can handle a 30-inch web, printing on one side only, with an impression of 7¼ x 30 inches, and cuts it into sheets, slits and perforates, with a capacity of 5,000 impressions an hour. It uses flat printing surfaces.

The Rotary Perfecting Press.— To fully perfect a press printing on a cylinder from a roll, or continuous web of paper, R. Hoe & Co., (in the words of Robert Hoe) in 1871 found these difficulties to be overcome:

> First—The set-off of the first side. Devices were used to overcome this, and the ink-makers were induced to pay special attention to the manufacture of rapid-drying or non-setting-off inks.
>
> Second —The difficulties of obtaining paper in the

roll of uniform perfection and strength. The papermakers were led to make a study of producing large rolls of paper meeting these requirements and became more and more experienced in its manufacture.

Third—The difficulty of the rapid severing of the sheets after printing.

Fourth—A reliable and accurate delivery of the printed papers.

These last two operations were not accomplished satisfactorily until the appearance of the Hoe machine. In this press the sheets were not entirely severed by the cutters, but simply perforated after the printing. They were then drawn by accelerating tapes, which completely separated them, onto a gathering cylinder so constructed that six perfect papers, or any other desired number, could be gathered, one over the other. These, by means of a switch, were at the proper moment turned off onto the sheet-flier, which deposited them on the receiving board. This gathering and delivery cylinder, patented by Stephen D. Tucker, a member of the firm of R. Hoe & Co., solved the problem of rapid flat delivery.

The first machine of this type that R. Hoe & Co. built went to London to 'Lloyd's Weekly,' and the first to be set up in the United States was used in the office of the New York *Tribune*. The limit of capacity depended on the ability of the web paper to stand the strain of passing through the press. The average speed was 12,000 perfect papers an hour, though in some offices a speed of 14,000 was reached, and on a test a speed of 18,000 was recorded.

The use of wood pulp in the manufacture of news papers (now universal) cheapened greatly the cost of paper, and a further stimulus was given to the manufacture of printing presses to increase speed and efficiency.

It was necessary that the newspaper sheets as delivered by the presses should be folded for delivery, and hand-fed folding machines were in use in every newspaper office. Into them the sheets were fed one by one. Each was carried by tapes under a striking blade that forced it between a pair of folding rollers. It was then similarly carried to another at right angles, and so on until the desired shape was reached. Such folders were made part of the fast presses, but as the limit of capacity of the folder was 8,000 sheets an hour, it was a drag until Stephen D. Tucker, in 1875, patented a rotating collecting cylinder, which doubled the capacity, and Walter Scott followed with an invention for making press and folder one machine.

This, however, was but the beginning. The pressure on the newspapers demanded larger than 8-page papers. It became necessary to revise some way to print 10-, 12-, 14-, and 16-page papers at one impression. About this time Anthony & Taylor, of England, patented devices by which the webs of paper could be turned over after printing on one side and the opposite, or reverse side, presented to the printing cylinder. Mr. Hoe bought the patent rights for England and the United States, and with them combined ideas patented by Luther C. Crowell, of Boston, who had made a machine for forming paper bags. After costly experiments these ideas were incorporated in a so-called «Double-Supplement» press, which was set up in the New York *Herald* office. Simplicity, speed, accuracy and efficiency had been combined. This press turned out either 4-, 6-, 8-, 10-, or 12-page papers at the rate of 24,000 an hour; the odd pages were accurately inserted and pasted in; the papers were cut and delivered folded. This press was really two presses built into one frame. In the secondary part the plate cylinders were half the length of those in the main part, and at right angles to them. These were used for the supplements of two or four pages when it was desired to print more than eight pages. Each part was fed by its individual roll of paper. The plates being secured to the cylinders, the two rolls of paper were carried, each through its part of the machine, between two pairs of plate cylinders and impression cylinders and printed on both sides. Then the two webs of paper passed over turning bars, or «angle bars,» with an edge at 45 degrees from its base, by which they were laid evenly and exactly one over the other as a brush from the paste fountain glided along the inner fold, pasting them together. The papers passed on down a triangular «former» that folded them along the centre margin. Thence the printed and folded web of paper passed over a cylinder, from within which a revolving blade projected and thrust the paper between folding rollers, while at the same moment a knife in the cylinder severed the sheet. A rapidly revolving mechanism, resembling in its motion the fingers of a hand, disposed of them accurately on traveling belts that hurried them on to the final delivery. Hundreds of this press have been built and operated in this country and abroad.

Straight-Line Presses.— The angle-bar press stood alone for a decade as having the only device, though somewhat cumbersome, for assembling the several sheets into one complete paper. Joseph L. Firm, foreman of the press-room at Frank Leslie's publishing house, however, solved the problem in a new way, and in 1889 patented the straight-line press. His first design was a simple tandem press. Three sets of cylinders were set in a straight line, and the printed product of the first passed over the second, and of the first and second over the third, thus assembling all three sheets over a triangular «former» for folding, cutting and delivering. It was but a step, to secure economy of construction and space, to build the press in tiers instead of tandem. Firm had the usual fortune of poor inventors. His first order, which was for a sextuple press, came from the New York *World*, and its building exhausted his resources. When set up, in 1891, it was so crudely and badly built that, failing to work properly, it was condemned. Poverty followed, but not for long. The Goss Printing Press Company of Chicago became interested in the straight-line press invention, which was being pirated, and bought it, taking Mr. Firm into the company. Litigation followed and established the patent and harmony among the printing press makers. Improvement was rapid. These presses mark the final development of the power printing press. Evolution and the requirements of the publishers of metropolitan newspapers have brought forward presses with various improvements of detail and in increasing sizes, until one press, so called, is a compound of two, four, six, eight, twelve presses built into one frame, one above the other, side by side or tandem, or all three for economy of space and power and efficiency, but the basic principle is the same,— a web of paper passes between two pairs of plate and impression cylinders and is printed on both sides; it is assembled (if on a double-supplement press or one of greater power), pasted, folded, cut or separated, folded again and delivered ready for the carrier or mail-room, at a speed of 48,000 eight-page papers (the unit of manufacture) an hour; and with an accuracy that denotes exactness and skill of manufacture, excellence of material and utmost care and nicety in adjustment and operation.

The first improvement in the Hoe type of fast press was the quadruple (or four-fold) press built for the New York *World* in 1887. A further advance in 1891 produced the sextuple (a six-fold press), so constructed that the cylinders were all parallel. The first press of this pattern was set up in the New York *Herald* office. Eighteen months were needed to construct it; it weighed fifty-eight tons, and was composed of about 16,000 pieces. It was fed from three rolls of paper, each over five feet wide, and consumed an equivalent of 52 miles of paper, the ordinary width of the *Herald* page, every hour. Its delivery capacity was 72,000 eight-page *Heralds* in one hour, or 20 a second. The cylinders, when at top speed, made 200 revolutions a minute.

In 1896 an octuple (eight-fold) press was built for the New York *World*, with a corresponding increase in output, and four double sextuples, with color-printing attachment, were constructed for the New York *Journal*. These are each 35 feet high, 17 feet long, 9 feet wide, weigh 110 tons and are composed of about 50,000 parts. It is possible, by associating the webs of paper, to collect and deliver twenty-four-page papers, and any combination between that and four-page papers, and in this, as in lesser presses of this type, each unit and any combination of units of the press may be run separately while the rest of the press is idle.

THE GOSS THREE-DECK STRAIGHT-LINE PRESS.

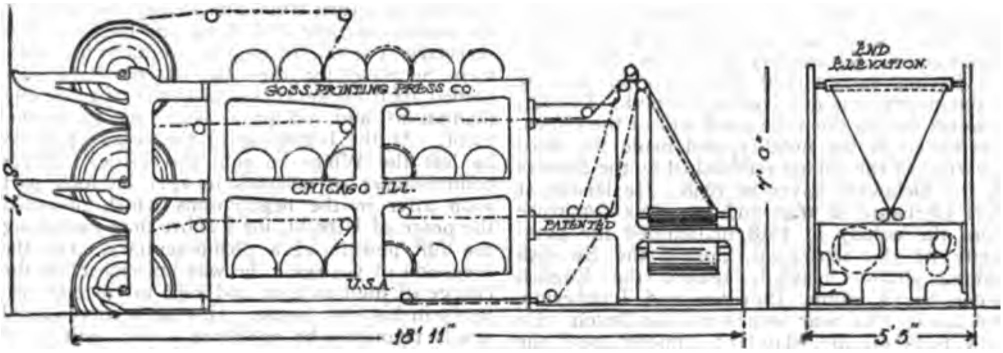


FIG. 4—Diagram of the sextuple unit. Dotted line shows the course of the three webs of paper, which are assembled on the triangular " former " or folder. This press is two plates wide, has a capacity of 24,000 four-, six-, eight-, ten-, or twelve-page papers an hour; or 12,000 sixteen-, twenty-, or twenty-four-page papers. It weighs 42,000 pounds and requires forty horse-power.

Even larger are the six giant double-octuple presses which R. Hoe & Co. designed for 'Lloyd's Weekly.' Two were set up and in operation in its office, Salisbury Square, London, by 1 Jan. 1904. Five months is required to build a press of this size. Each of these eight-roll presses can produce a 32-page paper, or, by collecting two of these before delivery, a 64-page paper, and, of course, any smaller combination of pages.

The 1902 patterns of the Goss press carry also "color decks," being an arrangement of two extra pairs of cylinders on the top of the machine, enabling the printing of three colors on the first and last pages of the newspaper. The largest Goss presses now in use are two in the office of the New York *Herald*,—called duodecuple, or twelve-fold. The *Herald* had two octuple presses and needed another. Its available floor space was entirely filled. The makers proposed to build in the air, as the press room was lofty, rising above the street level, and did on the same framework build another quadruple press on top of each of the octuples. Each press is now really made up of three quadruples, in tiers. Each can be operated individually; each delivers individually, the top press being fed and delivering its product on the mezzanine floor. In 1903 the New York *Herald* increased the size of its paper from a six-column page measuring 13¼ x 21 inches to a seven-column page measuring 15⅜ x 21¼ inches. It was able to make over its presses to accommodate the increased width of the web, though web and cylinders now barely clear the framework.

Newspaper Color Presses.—Ever searching for new features, New York newspaper publishers in 1902–3 were planning and designing supplements and main sheets embellished with color printing. Their scientific pressmen and the press-builders were called on to produce the desired effects. Walter Scott, of Plainfield, N. J., designed and built a very efficient press that was set up in the office of the New York *World* in 1893. This had five two-page wide color cylinders for electroplates set tandem, with a pair of cylinders for printing the reverse side in a single color, usually black. Below was a complementary stereotype cylinder machine for printing four pages in a single color; so that this machine could produce either a four-page paper, one Christmas supplement showing no side pages in five colors and the inside in a single color. By skilfully dividing the ink fountains, and combining colors and overprinting, many shades are produced in the same paper, one Christmas supplement showing no less than 36 shades. This press was removed to the office of the *Post-Dispatch*, in St. Louis, in 1902, where it is still doing very efficient work. To meet increasing demand *The World* had R. Hoe & Co. build an angle-bar double color-press in 1894, each side of which printed four (the two outside and the two inside) pages in four colors, and four pages in a single color; and another, a straight-line press, in 1898 with a capacity for four pages in five colors, and four pages in two colors; these two eights can be collected and delivered as a 16-page paper. The press will also produce a 24-page paper with four colors. The great problem to overcome was the offset from the color printing; this was done by bringing oil rollers into contact with the impression cylinders.

Color printing presses have been widely adopted by the American newspapers, and in the new models all the manufacturers offer «color decks.»

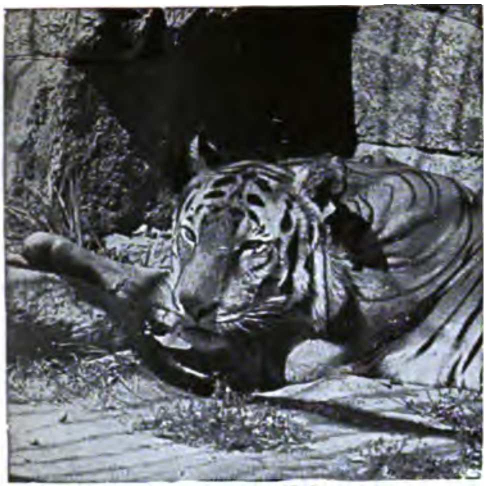
The skill of the American printing press manufacturers has produced so many designs, adapted to meet every demand of newspaper publishers, large and small, that it is impossible to enumerate the patterns. The presses here illustrated are sufficient to show the types. See NEWSPAPER PRINTING.

Printz, Johan, yō'hän prĭnts, Swedish colonial governor in America: b. Bottneryd, Sweden, about 1600; d. 1663. He fought in Germany in the Thirty Years war with the rank of a lieutenant-colonel of artillery in the Swedish army, but having surrendered Chemmitz in Saxony to the enemy, was deprived of his rank. In 1641, however, he regained the good will of the crown, was raised to the nobility, and made the third governor of the colony established by the Swedes on the Delaware River in 1638. He landed at Fort Christina in 1643 and until his departure from the colony in 1658 maintained the prosperity of the settlement, upheld the Swedish claims, almost unaided, against the English under Sir Edmund Plowden and Lamberton, and against his near neighbors, the Dutch. He built forts on the island of Tinicum near the mouth of the Schuylkill below Philadelphia, at Wilmington, and at New Castle, exerting much influence over the Indians along the Delaware and protecting his trade with them. At Tinicum he built himself a rude mansion, known as «Printz Hall.» The influx of settlers during his rule was made up of a good class of farmers who dealt fairly with the Indians and established a precedent of kindliness and justice acted upon so successfully afterward by William Penn. The only record of Printz after he returned to Sweden is that he was made a general and in 1658 was appointed governor of Jonköping. Consult: Smith, 'The Thirteen Colonies' (1901); Winsor, 'Narrative and Critical History of America' (1889).

Prion'idæ, a family or subfamily of longicorn beetles distinguished from its allies by the margined and usually toothed thorax. They are mostly insects of large size and robust form. Their larvæ are large, soft grubs with small heads but powerful jaws, which bore in wood and are very destructive. They rest in a nearly straight position, not bent or doubled. A number of conspicuous species are found in the United States, several of the most common belonging to the genus *Prionus*, in which the thorax bears three marginal teeth on each side, the joints of the long antennæ fit into one another in an imbricate fashion and number from 12 to 27. These insects are nocturnal, and the males are said to fight fiercely for possession of the females. One of the largest species is *P. brevicornis*, a common black beetle, which flies about in a heedless fashion at dusk. The huge larvæ, as large as a man's finger, live for three years; and are very injurious to the roots of poplar and other trees. A smaller and more slender beetle is *Orthosoma unicolor* which bores passages through the roots of grape vines. Other species are less destructive, confining their attacks chiefly to the dead wood of stumps and decaying tree trunks.

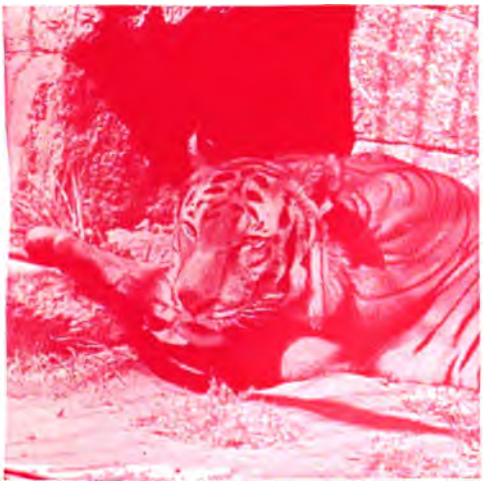
Prior, prī'ŏr, **Matthew,** English poet and diplomatist: b. Wimborne Minster, Dorsetshire (possibly Winburn, Middlesex), 21 July 1664; d. Wimpole, Cambridgeshire, 18 Sept. 1721. He was educated at Cambridge, and in 1688 was chosen fellow of his College, Saint John's. With Charles Montague he wrote in 1687 'The Country Mouse and the City Mouse,' a parody of Dryden's 'Hind and Panther.' Through the Earl of Dorset he was appointed secretary to the English plenipotentiaries at The Hague in 1690; in 1697 he became secretary to the commissioners who concluded the Peace of Ryswick, and on his return from The Hague, secretary to the Lord-lieutenant of Ireland, and finally under-secretary of state. In 1699 he produced his 'Carmen Seculare for the Year 1700.' He succeeded John Locke as commissioner of trade and plantations, and sat for a short time in Parliament. At the beginning of the reign of Anne he left the Whigs to join the Tories. Made commissioner of customs in 1711 he took part soon after in the negotiations which preceded the peace of Utrecht, for a short time exercising the full powers of a plenipotentiary. On the accession of George I. he was impeached on the charge of high treason and kept in custody two years in his own house. Having been rendered nearly penniless, he published a folio edition of his poems by subscription. He was buried in Westminster Abbey. Prior made his way chiefly by his wit and social qualities. His poetical powers were at their best in short occasional pieces in the flowing ease and vivacity of narration. Consult: Aldine edition of 'Prior's Poetical Works' (1892).

Prior, the chief coadjutor of an abbot in the government of an abbey, or the actual ruler of a monastic establishment. Not till the 13th century was prior used as a term significant of authority or rule, but rather of superiority of any kind, as experience, wisdom, advanced age. Till that time the abbot's coadjutor was styled *præpositus* (provost), but now he was called prior and under him, in great abbeys was the sub-prior. Then, the head of a small monastery, of Benedictine monks, for example, was called prior. Finally, the chief officer of a convent of Augustinians, or Dominicans, or Premonstratensians, had the same title, while the corresponding officer of a Franciscan house was known as *custos* (guardian); but the heads of houses of the military orders of St. John of Jerusalem, of Malta and of the Temple were also Priors. Prioresses in religious houses of women, whether abbeys or simply conventual establishments, had much the same authority as priors in religious orders of men.

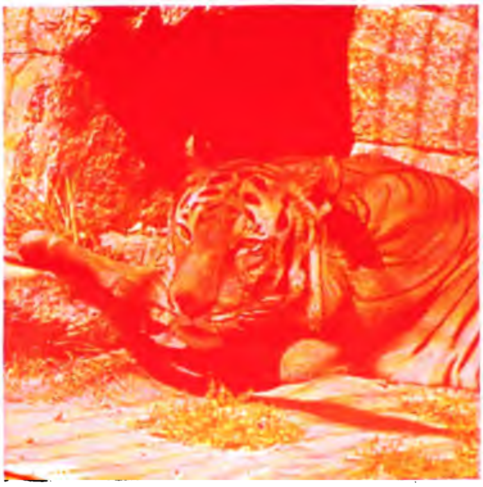


1. The Original Print

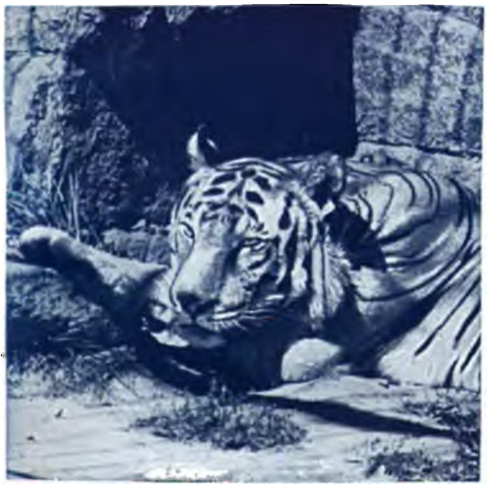
2. The Yellow Plate



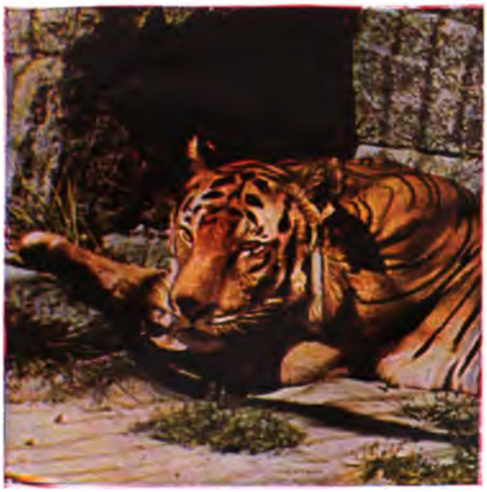
3. The Red Plate



4. Red and Yellow Combined



5. The Blue Plate



6. Combination of the Three Colors

Showing the different steps in obtaining a picture in colors from a single negative

Pripet, prĕp'ĕt (Russian, *Pripyat*), a river in the western part of Russia. It has its rise in the government of Volhynia, and is the outlet of several lakes; flows east and southeast and enters the Dnieper. It is about 500 miles long; navigable over 300 miles, and is connected with the Vistula and the Niemen by canals. Its upper course is through a vast uninhabited forest region, with large areas of marsh lands.

Priscian, prĭsh'ĭ-an (Latin, Priscianus Cæsariensis, prĭsh-ĭ-ā'nŭs sē-zā-rĭ-ĕn'sĭs), Roman grammarian of the 6th century, A.D. From his surname «Cæsariensis» it is supposed that he may have been born at Cæsarea. Almost all that is known of the facts of his life is that he taught Latin at Constantinople. His ‹Institutiones Grammaticæ,› in 18 books, a most thorough and comprehensive work, has chiefly preserved his fame. The first 16 books treat of the eight parts of speech recognized by the ancient grammarians. The last two are on syntax and are preserved separately in one manuscript, these bearing the title ‹De Constructione.› The whole work, successively abridged, formed the basis of instruction in Latin up to the 15th century.

Priscillian, prĭ-sĭl'ĭ-an, Spanish religious sectary: b. about 350; d. Treves 385. He was charged with teaching heresy resembling Gnosticism or the doctrine of the Manichæans and was excommunicated by the Synod of Saragossa (380). However, he was able by his eloquence to cause the judgment to be withdrawn and put to flight his chief opponent, the bishop Ithacius. The bishop later gained the support of Maximus, the usurper at Treves, and secured the condemnation and execution of Priscillian. The followers of Priscillian were known as Priscillianists. Their beliefs included peculiar views of the influence of the heavenly bodies upon men. The literary remains of Priscillian have been gathered in the 18th volume of the ‹Corpus Scriptorum Ecclesiasticorum Latinorum› (1889).

Prism, in geometry, a solid having similar and parallel bases, its sides forming similar parallelograms. The bases may be of any form, and this form (triangular, pentagonal, etc.) gives its name to the prism. In optics, any transparent medium comprised between plane faces, usually inclined to each other. The intersection of two inclined faces is called the edge of the prism, etc.; the inclination of the one to the other, the refracting angle. Every section perpendicular to the edge is called a principal section. The prism generally used for optical experiments is a right triangular one of glass, the principal section of which is a triangle. It is used to refract and disperse light, resolving it into the prismatic colors. See Light.

Prison Association of the United States, National, an organization of reformers and philanthropists, founded in Cincinnati, Ohio, in 1870, under the presidency of Rutherford B. Hayes. There is a board of directors and an executive committee of seven. Meetings are held annually. There are standing committees on criminal law reform, prison discipline, juvenile delinquency, etc.

Prison Reform. See Penology.

Prisoner of Chillon, The, a narrative poem by Lord Byron based on the story of the imprisonment of François de Bonnivard (1496-1570) in Château de Chillon, situated between Clarens and Villeneuve on Lake Geneva. It was Sir Walter Scott's opinion that as a picture, this poem, however gloomy the coloring, might rival any which Lord Byron had drawn.

Prisoners of War are persons captured from the enemy in time of war. Among the ancients prisoners of war became the slaves of their captors. When a hostile army enters a country, noncombatants are usually left unmolested, so far at least as their personal liberty is concerned. The combatants who have laid down their arms become prisoners of war, and their persons are at the entire disposal of the conquerors. The practice is to keep them in confinement till the termination of the war, or until a mutual exchange of prisoners between the warring states gives them their liberty. They are commonly treated in a somewhat similar manner to ordinary prisoners.

Prisons, Military, United States. See Military Posts, United States.

Prisrend, prēs-rĕnd', or **Perserim,** European Turkey, capital of the vilayet of Kosovo, on the right bank of the Rieka, four or five miles from its confluence with the Drin. It is the residence of a pasha, and the seat of a Greek metropolitan and a Catholic bishop. Among its buildings are 42 mosques, one Catholic and five Greek churches. It has considerable manufactures of fire-arms, and a large traffic with the adjacent country, and with many of the large towns in Albania, Rumelia, and Servia. Pop. about 39,000.

Pritchard, prĭch'ard, **Jeter Connelly,** American legislator: b. Jonesboro, Tenn., 12 July 1857. He entered a printing-office in early life, removed to Bakersville, N. C., in 1873, and until 1887 was joint editor and owner of the ‹Roan Mountain Republican.› He served in the State legislature in 1884, 1886, and 1890. In 1887 he was admitted to the bar and engaged in law practice in Marshall, N. C., was president of the State Protective Tariff League in 1894, served as United States Senator to fill a vacancy in 1894-7 and in the latter year was re-elected for the term of six years. In 1903 he became an associate justice of the Supreme Court of the District of Columbia.

Pritchett, prĭch'ĕt, **Henry Smith,** American astronomer and educator: b. Fayette, Mo., 16 April 1857. He was graduated from Pritchett College, Glasgow, Mo., in 1875 and later studied astronomy under Asaph Hall in the United States Naval Observatory where he became assistant astronomer in 1878. In 1880 he accepted the position of directing astronomer at Morrison Observatory, Glasgow, Mo., and in 1881 was appointed to the chair of astronomy and mathematics at Washington University, Saint Louis, Mo. He was permitted leave of absence in 1882 in order that he might observe the transit of Venus at Auckland, and he also made pendulum observations at Auckland, Sydney, Singapore, and Hong Kong. He was in Europe on scientific work in 1894-5, was appointed superintendent of the United States coast and geodetic survey in 1897, in 1900 president of the Massachusetts Institute of Technology, and in 1905 president of the Carnegie Foundation.

Privat Docent, prē-vät′ dō-tsĕnt′, in the German university system (and others modeled on it), an instructor whose lectures rank with those of the professors, but who unlike them has no standing in the faculty as a governing body of the university. He receives no fees except directly from his pupils. He must have received the doctoral degree and also be habilitated, that is, successfully defended a thesis, the result of his own research. The post is commonly a means of preparation for university professorships.

Private Schools, institutions under private control as distinct from public, and implying maintenance by private corporations or individuals. But the school may be private, or not public, in its origin and government, and if there are no limitations as to who may be admitted as pupils, it is usually classed as a public school. See RUGBY; SECONDARY SCHOOL.

Privateer′, the name applied in time of war to a ship owned by a private individual, which under government permission, expressed by a letter of marque, makes war on the shipping of a hostile power. To make war on an enemy without this commission, or on the shipping of a nation not specified in it, is piracy. Privateering was abolished by mutual agreement among European nations, except Spain, by the Declaration of Paris in 1856; but the United States of America refused to sign the treaty, except on condition that all private property at sea, not contraband, should be exempt from capture. This «Marcy,» or «American,» amendment, as it was called, was not accepted. This doctrine was again affirmed by the United States delegates to the Peace Conference at The Hague in 1898, but was again rejected by the European powers. It is doubtful, however, how far the abolition of privateering would stand in a general war, for it is the natural resource of a nation whose regular navy is too weak to make head against the maritime power of the enemy, especially when the latter offers the temptation of a wealthy commerce. It was usual for the country on whose behalf the privateers carried on war to take security for their duty respecting the rights of neutrals and allies, and their observing generally the law of nations. In the wars of 1793–1814 many English privateers were afloat. But in the same period no less than 10,871 English ships, with over $5,000,000,000, were taken by French «corsairs»; the Breton privateer Surcouf took, in two months of 1807, prizes worth $1,456,250. At the American Revolution the new republic fully realized the advantage of its position in preying on the mercantile marine of Great Britain; and in the War of 1812 British commerce suffered severely at the hands of American privateers, of which it was computed that some 250 were afloat. During the American Civil War the Confederate States offered letters of marque to persons of all countries, but no admittedly foreign vessels were so commissioned. During the same period the Congress of the United States empowered the President to grant commissions to privateers, but none such were granted. The Confederate cruisers were at first regarded in the North as mere pirates; and the «Alabama Claims» originated in the charge against Great Britain of allowing the departure of privateers from British ports, where they were fitted out illegally.

Privet, a genus (*Ligustrum*) of shrubs or trees of the order *Oleaceæ*. About 35 species are known, natives of eastern Asia, Australia, with one of the Mediterranean region. They are deciduous or evergreen and bear terminal panicles of small, whitish, generally fragrant flowers, followed by usually black berries which often remain on the plants during winter. They are justly popular plants in shrubberies and some are widely used as hedges since they are erect-growing and stand shearing well. They are readily propagated by means of cuttings, seeds, or layers, and will succeed in almost any soil, in full sun, on dry land, and under partial shade. The common privet (*L. vulgare*), *L. ibota,* and *L. ciliatum* are fully hardy in the Northern States, but the so-called California privet (*L. ovalifolium*), a Japanese species, is doubtfully hardy farther north than New York city. The berries of some species are eaten by birds, but are not of pleasant flavor. They supply a pink pigment used in map-making and in dyeing. The wood of some of the larger kinds is very hard and is used for making shoe-pegs and for turning. The only insect that is commonly troublesome upon the plants is the privet web-worm (*Diaphania quadristigmalis*).

Privilege taken in its active sense is a particular law, or a particular disposition of a law, granting certain special prerogatives to some person contrary to the common right. Examples of privilege may be found in all systems of law, as in the case of members of Congress and of the several legislatures when in attendance at their legislative duties; parties as witnesses while attending court, and coming to and returning from the same, electors while going or returning to the election, are all privileged from arrest except for treason, felony, or breach of the peace. Privileges from arrest are either general and absolute, or limited as to time or place.

Embassadors and their servants are absolutely so privileged.

A privilege of arrest for a legislature member is limited to the period of the legislative session and a reasonable time in going and returning.

In the civil law a privilege is a right which the nature of a debt gives to a creditor, entitling him to be preferred before other creditors.

Privileged communications are those statements made by a client to his counsellor or attorney in confidence, relating to some cause or action then pending; such communications cannot be disclosed without the consent of the client. The courts sometimes exclude from evidence, as privileged communications, matters of a judicial, political, or professional nature on the grounds of public policy.

In many jurisdictions a writ of privilege or protection is issued by the courts, affording one, under proper circumstances, protection against arrest or from the service of civil process.

A witness is entitled to the privilege of refusing to answer incriminating questions.

HENRY M. EARLE.

Privy Council, in England, the body of advisers of the sovereign which formally sanctions those acts of government not properly the province of Parliament. Privy councillors are nominated, without patent or grant, at the pleasure of the crown, excepting certain persons appointed *ex-officio*. They hold office for life, or for the life of the sovereign, so that at the accession of a new sovereign the council must be reconstituted. The number of privy councillors is not limited by law. At the present time the body contains about 250 members.

Jurisdiction.— The duty of the Council, in general, is to advise the king on affairs of state. The Lord President of the Council is required by statute «to manage the debates in Council, to propose matters from the sovereign at the Council Table, and to report to the sovereign the resolution of the Council thereon.» This function, however, is largely theoretical, as there are in fact no debates in council, this body merely giving formal sanction to orders in council, by which the king expresses his pleasure with respect to various administrative matters, as for instance, the bringing of treaties into effect, grants of charters, the government of colonies, and the regulating of departmental business. So, too, the Privy Council performs certain ceremonial functions. For instance, in council a bishop does homage for the temporalities of his see, a minister takes the oath of office, and the sheriffs for counties are chosen. The council has, besides, important duties of an administrative or judicial nature which it performs by committee or commission. Several of these committees have only a theoretical connection with the council, acting to all intents and purposes independently. The cabinet itself is such a committee, composed of ministers belonging to the Privy Council, but it has completely outgrown the parent body in political importance, having practically superseded it in the functions which this formerly performed. The board of trade, now under its own president and regarded as a distinct department of state, was from the first a committee of the Privy Council. The local government board of agriculture and the board of education are similar developments from the council, while the universities committee, the committee «for the consideration of charters of incorporation under the Municipal Corporations Act» of 1882 are still subordinate to the main body. The judicial functions of the Privy Council are carried on by its judicial committee, which includes the Lord Chief Justice and the four Lords of Appeal. It is concerned chiefly with appeals from colonial and Indian courts, has ecclesiastical jurisdiction and decides concerning petitions for extension of letters patent, copyright, etc. The Privy Council is summoned on a notice of 44 hours. Only on very extraordinary occasions is there a full attendance, the presence of six members being sufficient to constitute a council. Privy councillors have the title of «right honorable» and rank immediately after Knights of the Garter.

History.— The Privy Council developed out of the *curia regis* (king's council) of the Norman period, which exercised judicial, legislative, and administrative functions. Out of the *curia* grew the courts of law and equity and the houses of Parliament besides the Privy Council. After the time of Edward I. appeared the *concilium ordinarium,* or ordinary council of the king which in the 15th century gained the name Privy Council. The Select Council, ultimately the Cabinet, began to emerge from the larger body about the same time. In the time of Edward III. the Privy Council was occasionally merged in one assembly with the House of Lords, and in 1640 the Long Parliament reduced the powers of the council. In 1679 Sir William Temple made an unsuccessful attempt to reorganize it, but since then it has dwindled into insignificance when compared with its early authoritative position, and its governmental duties have been assumed by the Cabinet. Ireland has a separate Privy Council. Bodies, somewhat similar and bearing the same name, formerly existed in several of the American colonies and States. Consult: Macqueen, 'Appellate Jurisdiction of the Privy Council' (1842); Finlason, 'The Judicial Committee of the Privy Council' (1878); Dicey, 'The Privy Council' (new ed. 1887); Gneist, 'History of the English Constitution' (1891); Anson, 'Law and Custom of the Constitution' (1892).

Privy-purse, Keeper of the, an officer of the royal household of Great Britain, in charge of the payment of the private expenses, including charities, of the sovereign. He has no control over any official or household expenses, and is independent of the great officers of the household.

Privy-seal (*privatum sigillum*), a British governmental seal appended by the sovereign to such grants or things as are afterward to pass the great seal; and sometimes used in matters of less consequence, which do not require to pass the great seal, as to discharge a recognizance, debt, etc.; no writ, however, which relates to the common law can pass the privy-seal. Since the time of Henry VIII. the privy-seal has been the warrant of the legality of grants from the crown, and the authority for the lord-chancellor to affix the great seal. Such grants are termed letters-patent. The officer who has the custody of the privy-seal was anciently called clerk of the privy-seal, afterward guardian *del* privy-seal; now he is called lord privy-seal, and is the fifth great officer of state, having also generally a seat in the cabinet. The lord privy-seal must not put the seal to any grant without good warrant; nor with warrant if it be against the law or inconvenient without first acquainting the sovereign therewith.

Prix de Rome, prē dė rōm (French, «prize of Rome»), a prize offered by the French government to art students by which they are enabled to prosecute their studies in the capital of Italy. It was founded by Louis XIV. in 1666 and enlarged by Napoleon. Those eligible for the prize are painters, sculptors, architects, musicians, and engravers, and the privilege bestowed consists of an income of some 4,000 francs for four years with access to the Académie de France at Rome and exemption from military service. Candidates must be Frenchmen between the ages of 15 and 30, and must have done certain work at the Ecole des Beaux Arts or elsewhere. The competition is so arranged as to comprise only ten students from each department for the final comparison, and these are allowed three months in which to accomplish the work they put in for the prize. While studying at Rome the successful competitor is expected to send to the Salon, or if he be a musician to the Conservatoire, every year, specimens of the work he is engaged in, and thus report progress.

Prize, that which is taken from an enemy in war; that which is seized by fighting, especially a ship, with the goods contained in her; any description of goods or property seized by force as spoil or plunder. The law as to prizes taken at sea is regulated by international law. In order to vest the title of the prize in the captors it must be brought with due care into some convenient port for adjudication by a competent court.

Prize-court, in times of war, a court established to adjudicate on prizes captured at sea. In the United States, the United States District Courts have jurisdiction both as instance and prize courts, there being no distinction in this respect as in England, where the prize-court is a separate branch of the court of admiralty. See ADMIRALTY LAW.

Prize-money, in warfare, money paid to the captors of a ship or place where booty has been obtained, in certain proportions according to rank, the money being realized by the sale of the booty.

Prjevalsky, przhā-väl'skē, or **Prejevalski,** prā-zhā-väl'skē, **Nicholas,** Russian traveler: b. Otradny, government of Smolensk, 31 March 1839; d. Karakol, West Turkestan, 1 Nov. 1888. Having joined the army in 1855 he assisted in quelling the Polish insurrection of 1861. While stationed in Siberia in 1867 he explored the Usuri region, south of the Amur, and spent 1871–3 in traveling from Peking through southern Mongolia (region of the Ordus) to the Ala-shan, Koko-nor, and the upper waters of the Yang-tse-Kiang. In 1876–7 he explored Lob-nor on the borders of East Turkestan and China, and in 1879 reached a point some 160 miles north of Lhassa, when the Tibetan authorities turned him back. He reached Kiachta after a journey of nearly 15,000 miles. In 1883–4 he again crossed the Desert of Gobi, but returned without being able to reach Lhassa. He died just as he was starting on his fifth expedition. Prjevalsky brought back from these journeys valuable collections of animals and plants, all now preserved at St. Petersburg. His accounts of his journeys were published in the ‹Proceedings› of the St. Petersburg Geographical Society in ‹Petermanns Mitteilungen› and other journals.

Pro'a. See CATAMARAN.

Prob'abilists, those philosophers who maintain that certainty is impossible, and that we must be satisfied with what is probable. This was the doctrine of the New Academy, particularly of Arcesilaus and Carneades. The last-mentioned philosopher distinguished three principal degrees of probability, according as a representation might be probable when considered by itself alone; probable and unimpeached when compared with others; or thirdly, probable, unimpeached and in all respects confirmed. In morals probabilists are those who teach that in our actions we must follow what seems to us probably right, because in questions of morality demonstrative certainty is not to be attained. There are some Christian teachers (and among them Gury in his ‹Compendium Theologiæ Moralis›) who taught that a man may follow what is probably right, or what has been decided to be so by teachers of authority, although it may not be the most probably right, or may not seem probable to himself. It is this view that Pascal in his famous ‹Provincial Letters› holds up to ridicule. Butler in his ‹Analogy› bases his argument on probability, to which he applies the term «moral certainty.»

Probability, Theory of, is that branch of mathematics which deals with the determination of the degree of belief which, in the absence of full information, should be given to certain classes of statements, or to the past or future occurrences of certain events.

In regard to the great majority of events there is in the mind of every one a state of uncertainty. Under differing circumstances one shows this uncertainty by saying that it is possible or that it is, or is not, probable that some event did or will happen. Ordinarily no attempt is made to establish an exact measure of the probability of an event, such attempt being clearly foredoomed to failure. Not infrequently, however, the first step toward such a measurement is taken by the making of a rough comparison of the probabilities of two events, the conclusion resulting that one of them is *more* probable than the other.

Equally Probable Events.—For certain sorts of events it is possible to proceed farther. Thus, as a next step, it is quite common to find that two events are regarded as *equally* probable. For instance, a coin being tossed, one says that head and tail are equally likely to appear; or, a properly made die being thrown, one estimates that any one of the six faces is as likely to appear as any other. Of course these estimates are made in spite of the belief that, starting from a given initial position, the body moves completely subject to the laws of dynamics, and that from certain influences but one result can follow. The fact is that the observer is so ignorant of the forces applied to the body that his judgment is formed independently of them. He perceives that from the nature of the body only a certain number of events are possible, and he finds no reason for concluding that one event rather than another will occur.

Probability of an Event.—Suppose now that five events are known to be equally probable, and that one of them will and only one can happen. Suppose also that if and only if one or another of the first three occurs, a further event E will occur. Then it is commonly said that the odds are 3 to 2 in favor of the event E: and since there are five equally probable events, of which exactly three are concurrent with E, it is said that the mathematical probability of E is $\frac{3}{5}$. In general, *when a specified event E is governed by n equally probable events, of which one will and only one can happen, and when, of m of these, each is decisively favorable to E, all others being decisively unfavorable, the mathematical probability of E is defined to be* $\frac{m}{n}$. In the extreme cases in which none and all of the events, respectively, are favorable to E, the probabilities are said to be 0 and 1, though in each case there is certainty regarding the occurrence of E.

Assume now that, of n equally probable and mutually exclusive governing events, $m_1, m_2, \ldots, m_\kappa$ are respectively favorable to the further events $E_1, E_2, \ldots, E_\kappa$, which are also mutually exclusive. Then the probabilities of $E_1, E_2, \ldots, E_\kappa$ are respectively $p_1 = \frac{m_1}{n}$, $p_2 = \frac{m_2}{n}$, $\ldots$, $p_\kappa = \frac{m_\kappa}{n}$. If now $m_1 + m_2 + \ldots + m_\kappa = n$, one has $\frac{m_1}{n} + \frac{m_2}{n} + \ldots + \frac{m_\kappa}{n} = 1$; or $p_1 + p_2 + \ldots + p_\kappa = 1$. This result may be stated formally as

Theorem 1. The sum of the mathematical probabilities of a number of events, of which one must and only one can happen, is unity.

The application of the definition requires the selection of a set of governing events, finite in number, which must be either equally probable or capable of being replaced by a set of equally probable events; it then requires a correct enumeration of the favorable events and of the whole set. Each of these steps may present difficulties, but failure follows most frequently from a wrong selection of the set of governing events. Consider the following example:

Ex. 1. A coin being tossed twice, what is the probability that head appears twice?—One might say that the possibilities, or governing events, are three in number, viz., the appearances of two heads, of a head and a tail, and of two tails, respectively; that of these one is favorable, and that $p=\frac{1}{3}$. But the answer is incorrect because the appearance of two heads, or two tails, is not as probable as that of a head and a tail. The following are really equally probable events: the appearance of head, head; of head, tail; of tail, head; of tail, tail. They are four in number, one being favorable. Hence $p=\frac{1}{4}$.

The solutions of the following problems illustrate the direct application of the definition. Nearly all problems in this subject require the use of the theory of permutations and combinations. (See ALGEBRA, *Permutations and Combinations.*)

Ex. 2. Two dice being thrown, what is the probability that the throw will be seven?—The equally probable events are the appearances of the several numbers of the first die with those of the second die, and are 36 in number. The favorable cases are the following sets: 1, 6; 2, 5; 3, 4; 4, 3; 5, 2; 6, 1; they are six in number. Hence $p=\frac{6}{36}=\frac{1}{6}$.

Ex. 3. Two dice being thrown twice, what is the probability that at least one double appears?—In either throw any face of one die may be associated with any one of the other. Hence there are 36 equally probable cases for each throw. Each case for the first throw may be associated with each case for the second throw. Hence there are $36^2=1296$ cases in all. Of the 36 cases in either throw 30 will fail to yield a double. The association of each of these cases for the first throw with each of these for the second throw will yield all of the *unfavorable* cases. Hence there are $30^2=900$ unfavorable cases, and accordingly, $1296-900=396$ favorable cases. Hence $p=\frac{396}{1296}$.

Ex. 4. (a) From a bag containing five balls some are to be drawn. Find the probability that an even number of balls will be drawn. (b) Find also the probability if the number of balls be n.—(a) The total number of cases is the sum of the numbers of ways of drawing 1, 2, 3, 4, and 5 balls, which is $5+10+10+5+1=31$. The numbers of ways of selecting 2 and 4 balls are 10 and 5. Hence the number of favorable cases is 15. Hence $p=\frac{15}{31}=\frac{1}{2}-\frac{1}{62}$.

(b) The total number of cases is

$$ {}_nC_1+{}_nC_2+\ldots+{}_nC_n. $$

The number of favorable cases is ${}_nC_2+{}_nC_4+\ldots$

Now $\qquad (1+1)^n=1+{}_nC_1+{}_nC_2+\ldots+{}_nC_n,$

and $\qquad (1-1)^n=1-{}_nC_1+{}_nC_2-\ldots.$

Hence $2^n-1=$ total number of cases. Also

$$ 2^n-2=2({}_nC_2+{}_nC_4+\ldots), \text{ and so } p=\frac{2^{n-1}-1}{2^n-1}. $$

Notice that an odd number of balls is more likely to be drawn than an even number.

Another problem remarkable alike for its apparent difficulty, the fine reasoning employed in its solution, and the simplicity of its results is the following one:

Ex. 5. At an election two candidates A and B received respectively a and b votes, A being elected. What is the probability that during the counting of the ballots A was always ahead?—The solution is obtained easily after it is shown that of the orders of counting which are unfavorable to the result mentioned exactly one-half begin with a vote for A. The answer is $p=\frac{a-b}{a+b}$, i.e., *the majority divided by the total vote.*

TOTAL PROBABILITY. COMPOUND PROBABILITY.

It may happen that the m governing events favorable to E can be classified into sets of m_1, $m_2, \ldots, m_k$ events respectively, where $m=m_1+m_2+\ldots+m_k$. The probability, p_1, that E will be concurrent with one of the set of m_1 events is $\frac{m_1}{n}$. Then since $\frac{m_1}{n}+\frac{m_2}{n}+\ldots+\frac{m_k}{n}=\frac{m}{n}$, one has $p_1+p_2+\ldots+p_k=p$. Stated formally one has

Theorem 2. If an event can happen in several mutually exclusive ways, the probability of its happening at all is equal to the sum of the probabilities of its happening in the several ways.—Here p is called the *total probability*, p_1, p_2, etc., the *partial probabilities*. On the other hand the event E whose probability is sought may consist in the concurrence of several independent events. Suppose that these events are e_1, $e_2, \ldots, e_k$, and that for them the total numbers of cases are $n_1, n_2, \ldots, n_k$, respectively, and that the numbers of favorable cases are m_1, $m_2, \ldots, m_k$, respectively. Then for the event E the total number of cases is $n_1n_2\ldots n_k$, and of these $m_1m_2\ldots m_k$ are favorable. Hence

$$ p=\frac{m_1m_2\ldots m_k}{n_1n_2\ldots n_k}=\frac{m_1}{n_1}\,\frac{m_2}{n_2}\ldots\frac{m_k}{n_k}=p_1p_2\ldots p_k. $$

Hence one has

Theorem 3. The probability of the concurrence of several independent events is the product of the probabilities of their several occurrences.—This theorem can be extended to the cases in which events, not independent, have a specified order, and in such cases the probability of each is to be computed on the hypothesis that the preceding events have happened.

These three theorems form the basis of the whole of the elementary theory. Their application will be illustrated in the solution of the following example:

Ex 6. A with three coins endeavors to throw more heads in one throw than B can throw with two coins. In case of a tie they throw again. What is the probability of A's winning?—The following ways in which A can win include all cases, and are mutually exclusive. He may (1) throw 3 heads, (2) throw 2 heads and win, (3) throw 1 head and win, (4) he may tie B on the first throw and win on a subsequent throw. Let p be the total probability of A's winning, and p_1, p_2, p_3, p_4 the partial probabilities. The following table gives the chances of various throws by A and B:

Number of heads	3	2	1	0
A's chance	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{8}$
B's chance	0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{4}$

Then, by theorem 3, $p_1=\frac{1}{8}$, $p_2=\frac{3}{8}(1-\frac{1}{4})$, $p_3=\frac{3}{8}(1-\frac{1}{4}-\frac{1}{2})$. Also p_4 is the product of the probabilities that a tie will occur and that A will subsequently win. The probabilities that a tie will occur with 3, 2, 1, 0 heads are 0, $\frac{3}{8}\times\frac{1}{4}$, $\frac{3}{8}\times\frac{1}{2}$, $\frac{1}{8}\times\frac{1}{4}$. The sum is $\frac{5}{16}$. If a tie occurs, the initial condition is reproduced and A's chance of winning is p. Hence $p_4=\frac{5}{16}p$. Then, by theorem 2, $p=\frac{1}{8}+\frac{9}{32}+\frac{3}{32}+\frac{5}{16}p$, whence $p=\frac{8}{11}$.

PROBABILITIES OF REPEATED EVENTS.

An interesting part of the theory is that relating to repetitions of events. Consider an event whose probability is p, and let $q=1-p$. Suppose that n trials are made. The probability that the n trials will result in s occurrences and $(n-s)$ failures of the event, in a specified order, is p^sq^{n-s}. But the number of different orders is $\frac{\underline{|n}}{\underline{|s}\,\underline{|n-s}}$. Hence the probability that in n trials there will be exactly s occurrences is $\frac{\underline{|n}}{\underline{|s}\,\underline{|n-s}}p^sq^{n-s}$. By considering different values of s one may find the probability that the number of occurrences shall lie between specified limits. Thus if a coin be tossed ten times, one finds the probabilities of the appearances of exactly four, five, and six heads to be $\frac{210}{1024}$, $\frac{252}{1024}$, $\frac{210}{1024}$; and the probability that the number of heads will not differ from five by more than one is $\frac{672}{1024}$, or $\frac{21}{32}$.

An easy problem is the determination of that number of occurrences which is most probable. It is necessary only to compare the results of giving to s consecutive values between zero and n to discover that for the most probable case s must be so chosen that the fraction $\frac{s}{n}$ is as nearly as possible equal to p. Hence in ten throws, the most probable number of heads is 5 because $\frac{5}{10}=\frac{1}{2}=p$. Likewise in 73 throws with one die the most probable number of throws of aces is 12, since $p=\frac{1}{6}$, and $\frac{12}{73}$ is the fraction having the denominator 73 and being most nearly equal to $\frac{1}{6}$.

Of particular interest is the case in which the number of trials is very large. In this case the evaluation of the probability may be made approximately by the use of Stirling's formula: $n=n^{n+\frac{1}{2}}e^{-n}\sqrt{2\pi}$, where e is the Napierian base. By this means many interesting results may be derived. Thus if p_0 denote the probability of that number of occurrences which is most probable, $p_0=\frac{1}{\sqrt{2\pi npq}}$; and if P_l denote the probability that the number of occurrences shall not deviate from the most probable number by more than l, which does not exceed a small multiple of $\sqrt{n}$, then

$$P_l=\frac{2}{\sqrt{\pi}}\int_0^{\gamma} e^{-t^2}dt+\frac{e^{-\gamma^2}}{\sqrt{2\pi npq}},$$

where $\gamma=\frac{l}{\sqrt{2npq}}$. The results here obtained are due to James Bernoulli, and are usually combined in a statement of what is called

Bernoulli's Theorem. If an event has a constant probability, p, and if $q=(1-p)$, then, n trials being made, the most probable result is that in which the ratio of the number of occurrences to the number of trials is most nearly equal to p. The number of trials being very great, the probability that the deviation of the number of occurrences from the most probable number shall not exceed l is

$$P_l=\frac{2}{\sqrt{\pi}}\int_0^{\gamma} e^{-t^2}dt+\frac{e^{-\gamma^2}}{\sqrt{2\pi npq}},$$

where $\iota=\gamma\sqrt{2npq}$, and l does not exceed a small multiple of $\sqrt{n}$.

For very many purposes in the Theory of Probability the definite integral $\int_0^{\gamma} e^{-t^2}dt$ is of great importance, and so tables of its values for different values of γ have been prepared. It may be shown, too, that a very good approximation to the value of P_l is given by the equation $P_l=\frac{2}{\sqrt{\pi}}\int_0^{\gamma'} e^{-t^2}dt$, where $\gamma'=\frac{l+\frac{1}{2}}{\sqrt{2npq}}$.

From the tabulated values of the probability integral, $\frac{2}{\sqrt{\pi}}\int_0^{\gamma'} e^{-t^2}dt$, the following facts regarding P_l become evident. *First*, the deviation l being specified, the values of γ' and of P_l decrease rapidly as n increases. In fact if the number of trials be increased sufficiently, the probability that the specified deviation will not be exceeded can be made smaller than any fraction assigned in advance. *Second*, if γ', and hence P_l, be specified, the corresponding deviation l increases rapidly as n increases, but the relative deviation, or the ratio of the deviation to the number of trials, decreases rapidly.

To illustrate these statements let it be recalled that, a coin being tossed ten times, the most probable result is five heads and five tails, and the probability that the deviation of the number of heads (from five) should not exceed one was found to be $\frac{21}{32}$. Consider now the cases of 10,000 and 10,000,000 trials. A careless examination might suggest that for the same probability, $\frac{21}{32}$, the corresponding deviations would be 1000 and 1,000,000 respectively. As a matter of fact, simple computations show that they are not more than 50 and 1500 respectively.

The very close relation which existed between the theory of probability and the study of games of chance makes it exceedingly interesting to see what conclusions can be drawn regarding the probable results of persistent gambling. Bernoulli's theorem applies directly. Since the conclusions for all cases are similar it will be most satisfactory to consider a simple one.

Suppose, then, that A, with a capital of $1000, repeatedly bets $10 evenly that the toss of a coin will yield head. The game seems fair, and it might appear that in the long run A would neither win nor lose. Notice, however, that A will be ruined whenever he shall have lost 100 times more than he has won. The theory shows that of all possible cases the most probable is that in which the numbers of heads and tails are equal. But the probability of this result is $\sqrt{\frac{2}{\pi n}}$, and it evidently decreases rapidly as n increases. Bernoulli's theorem shows that, if the number of trials be about 25,000, the probability that the deviation shall exceed 100 is about $\frac{8}{10}$. Hence the chance that *A* will neither win nor lose the amount of his present fortune soon becomes inconsiderable. One may say, then, that in the long run *A* will either be ruined or will at least double his fortune; and the chances of these events appear to be even. As a matter of fact *A* is at a serious disadvantage. For many runs of results which might ultimately be favorable to him are excluded because in their beginnings he has so many losses that he must cease play for lack of money. On the other hand all runs which begin favorably but ultimately become unfavorable must be counted because A does not stop as long as he wins. Hence the equality of the chances is destroyed.

MATHEMATICAL EXPECTATION.

A person who has a possibility of securing without cost a property of any sort places upon that possibility a value which depends upon that of the property and upon the probability of his securing it. In our subject a definite valuation is placed upon such a possibility. This valuation is called its *mathematical expectation* and is defined to be *the product of the value of the property and the probability of getting it.* More generally, if there are several gains, a_1, $a_2, \ldots, a_n$, with the respective probabilities, $p_1, p_2, \ldots, p_n$, the mathematical expectation arising from these gains is $E = p_1a_1 + p_2a_2 + \ldots + p_na_n$. In this connection losses may be treated as negative gains. It is not denied that such an estimate involves the disregard of many elements, but unquestionably in the applications of this definition which are generally made such disregard is reasonable. To be more specific, it is extremely unlikely that a poor man would regard a possible gain of $2000, whose probability is $\frac{1}{2}$, as equivalent to the actual possession of $1000. On the other hand such an estimate is made the basis of all insurance business, and is justified by the results obtained.

The connection between mathematical expectation and gambling is evident. If a person throws a die and is to receive $600 in case an ace appears, his expectation is $600 × $\frac{1}{6}$ = $100. Unquestionably $100 would be regarded as a fair entrance-fee to one who could afford to repeat the trial a number of times. In this connection the condition under which a game is said to be *fair* may be mentioned. Suppose that a player has to pay a stake b to enter a game in which his chance of winning a sum a is p. Then for a fair game $b = pa$, or his expectation after his entry must be equal to his stake.

The derivation from the definition of mathematical expectation of certain results which seemed to him to be impossible of acceptance led Daniel Bernoulli to develop a theory of *moral expectation* which has received some considerable attention. Bernoulli laid down the principle that to the possessor of a fortune a the *moral value*, v, of a small gain h is directly proportional to the amount of the increase, and inversely to this present fortune; or that $v = k \cdot \frac{h}{a}$ (where k is a constant); and that if the probability of this gain is p, the moral expectation arising from it is $pv = \frac{pkh}{a}$. The results obtained from this estimate differ widely from those obtained under the preceding one. They do, however, become less widely divergent from the latter as a increases, and in fact as a increases indefinitely the two sets of results tend to a perfect agreement.

PROBABILITIES DERIVED FROM EXPERIENCE.

Probabilities of Causes.—Hitherto the determination of the probability of an event has been based directly or indirectly upon certain governing events. A problem of another sort comes up for consideration. In the discussion of this problem and similar ones the word *cause* will be given an unusual meaning. For the present purposes the term will be used to mean a set of circumstances which might have given rise to an event. The problem may be stated as follows:

It is known that an event E has happened, and it is known that one of several causes has given rise to the occurrence of E; it is required to determine the probability that E arose from a specified one of the causes.

A concrete example is furnished by the following problem:

Ex. 7. Two bags contain respectively one white and one black ball, and one white ball and nine black ones. A ball has been drawn from one of the bags, has been observed to be white, and has been replaced. What is the probability that it was drawn from the first bag?—Let p be the required probability. There are two ways of computing the probability of drawing a white ball from the first bag. In the first place it is necessary that the first bag should be selected and that, it having been selected, a white ball should be drawn. This gives $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ as a result. In the second place it is necessary that a white ball should be drawn and that, having been drawn, it should have come from the first bag. This yields $(\frac{1}{2} \cdot \frac{1}{2} + \frac{1}{2} \cdot \frac{1}{10})p$. Hence, equating these values one gets $p = \frac{5}{6}$.

Similar reasoning applied to the general case yields the following result:

Theorem 4. If an event E has occurred as a result of one or another of certain causes C_1, $C_2, \dots, C_n$, whose respective probabilities previous to the occurrence of E were $\pi_1, \pi_2, \dots, \pi_n$, and if, when any one of the causes, as C_i, is known to be operating, the probability that it will produce E is p_i, then the probability, P_i, that E resulted from C_i is $P_i = \dfrac{p_i\pi_i}{p_1\pi_1 + p_2\pi_2 + \dots + p_n\pi_n}$.

Apply the result to the following example:

Ex. 7. From a bag containing five balls, each of which is either white or black, four drawings have been made, the ball being replaced after each drawing. The result is 3 white balls and 1 black one. What are the probabilities that the bag contains (1) 4 white, 1 black ball, (2) 3 white, 2 black, (3) 2 white, 3 black, (4) 1 white, 4 black?—There are four causes: (1) 4 white, 1 black, (2) 3 white, 2 black, etc., and before the drawing they were equally probable. Hence $\pi_1 = \pi_2 = \pi_3 = \pi_4 = \frac{1}{4}$. Also $p_1 = (\frac{4}{5})^3\frac{1}{5}$, $p_2 = (\frac{3}{5})^3\frac{2}{5}$, $p_3 = (\frac{2}{5})^3\frac{3}{5}$, $p_4 = (\frac{1}{5})^3\frac{4}{5}$. Then $P_1 = \frac{64}{146}$, $P_2 = \frac{54}{146}$, $P_3 = \frac{24}{146}$, $P_4 = \frac{4}{146}$.

When the number of causes is very great the formula of theorem 4 becomes unwieldy. It is found that a simpler formula gives an approximate result. The method used in deriving this formula will be illustrated in the following example:

Ex. 8. From among an exceedingly great number, N, of balls, each of which is either black or white, n balls are drawn, each ball being replaced before the next drawing. Of these exactly s are white. What are the probabilities for the various possible numbers of white and black balls in the whole set?—Since before the drawings nothing was known as to the desired result, the *a priori* probabilities for all numbers of white balls from 0 to N are equal. Now the total number of white balls will be known if the ratio, r, of that number to N be known. Hence equally probable values of this ratio are all proper fractions having N as denominator. Since N is very great, r varies from 0 to 1 by very small increments. *It will now be assumed* that for purposes of approximation r may be treated as varying continuously from 0 to 1. Also, if r is the correct ratio, the probability that in n drawings s white and $(n-s)$ black balls would appear is $\dfrac{|\underline{n}}{|\underline{s}\,|\underline{n-s}}r^s(1-r)^{n-s}$. If r varies continuously from 0 to 1, the probability of any specified value of r is zero, but the *a posteriori* probability that the ratio shall lie between r and $r+dr$ is $p_r = \dfrac{r^s(1-r)^{n-s}dr}{\int_0^1 r^s(1-r)^{n-s}dr}$ $= \dfrac{|\underline{n+1}}{|\underline{s}\,|\underline{n-s}}r^s(1-r)^{n-s}dr$, since the number of values of $r^s(1-r)^{n-s}$ as r varies from r to $r+dr$ is measured (see next section, *Geometrical Probability*) by dr; and the probability that r shall lie between r_1 and r_2 is

$$P = \frac{|\underline{n+1}}{|\underline{s}\,|\underline{n-s}}\int_{r_1}^{r_2} r^s(1-r)^{n-s}dr.$$

A general theorem might be formulated embodying this result, and such a theorem jointly with theorem 4 would constitute what is called the Theorem of Bayes.

The maximum value (see CALCULUS, INFINITESIMAL, *Maxima and Minima*) of $r^s(1-r)^{n-s}$ is obtained by putting $r = \frac{s}{n}$, and is $\dfrac{s^s(n-s)^{n-s}}{n^n}$. Then the most probable case is that in which the actual ratio of the number of white balls to the total number is the same as the corresponding ratio in the observed results.

A discussion of the value of P, which must be omitted, yields the following notable result:

Theorem 5. The probability that, under the conditions of example 8, the ratio of the number of white balls to the total number shall not deviate from its most probable value, $\frac{s}{n}$, *by more than* $r\sqrt{\dfrac{2s(n-s)}{n^3}}$ *is* $\dfrac{2}{\sqrt{\pi}}\int_0^r e^{-t^2}dt$.

Empirical Probabilities.—The preceding theory finds application in connection with any sets of events which for the purposes of any discussion may justly be compared with the drawing of balls from a bag. In some of the important connections this theory is in fact indispensable. It will be noted that in both of the examples 7 and 8 the inquiry was in regard to the probability of the various possible numbers of white and black balls. But if the ratio of the number of white balls to the total number of balls be known, that ratio furnishes the probability that a further single drawing will produce a white ball; and in general this probability is what is most urgently sought. Probabilities estimated in this way from observed events are called *empirical probabilities*.

Two methods of deriving empirical probabilities are used, one theoretically correct, but leading to troublesome computations, the other avowedly approximate only. The latter method involves the assumption that, of the possible causes of the observed event, that which has the greatest *a posteriori* probability is the true one. These two methods will be applied to example 7.

Suppose that after the drawing of the balls from the bag the question be asked, "What now is the probability of drawing a white ball?" By the first method the answer would be obtained as follows: The most probable state of the bag is that it contains 1 black and 4 white balls. Hence the probability of drawing a white ball is $\frac{4}{5}$.

The following is the other method of treatment: The probability that the bag contains 4 white balls and 1 black one and that a white one will be drawn from it is $\frac{64}{146}\times\frac{4}{5}$; that it contains 3 white and 2 black and that a white one will be drawn is $\frac{54}{146}\times\frac{3}{5}$; that it contains 2 white and 3 black and that a white one will be drawn is $\frac{24}{146}\times\frac{2}{5}$; and that it contains 1 white and 4 black and that a white one will be drawn is $\frac{4}{146}\times\frac{1}{5}$. Hence the probability that a white ball will be drawn is $\frac{47}{73}$.

Where the number of causes is greater the difference between the two values is smaller, and theorem 5 shows that when the number is very great the difference can be very small indeed, as it becomes nearly certain that the ratio r differs by very little from $\frac{s}{n}$.

GEOMETRICAL PROBABILITY.

In what precedes it has been assumed except in one case (see preceding section) that the number of equally probable events governing the event E is finite. The definition may be extended to include the case in which the number of events is infinite provided appropriate measures for the totalities of cases can be devised. Such measures are available when each case corresponds to a set of values or one or more continuous variables. Problems requiring the adoption of such measures are generally geometrical, and hence this branch of the subject is called *geometrical probability*. Merely an indication of its nature may be given by one or two very elementary examples.

Although the number of points on any line segment cannot be counted, yet their totality may be measured by the length of the segment. Similarly the totality of points in an area may be measured by that area; and so on. The probability that, all values being equally probable, a number less than unity is also less than one-half is ½ because the totality of cases is measured by a unit segment, and that of the favorable cases by half a unit segment. Similarly, if all points within a circle of radius a are equally likely to be selected, the probability that one of them selected, at random, is not distant more than $\frac{a}{2}$ from the center is ¼.

Many very interesting problems have been solved, some of them by exceedingly ingenious methods, but this branch of the subject is quite special and cannot receive further attention here.

In what precedes some important parts of the theory have been indicated. A study of its important applications, notably those to the discussion of errors of observations and to problems of insurance, must be sought elsewhere. The growth of the importance of the subject has been remarkable, for in the beginning it was concerned with problems of gambling, and it has become the basis of all forms of insurance. It has attracted and held the deep attention of nearly all the ablest mathematicians from Cardan to Sylvester and Poincaré. Among its devotees have also been Pascal, Fermat, De Moivre, Leibnitz, the Bernoullis, D'Alembert, Euler, Lagrange, Bayes, Condorcet, Laplace, Poisson, De Morgan, Bertrand, and Czuber. The theory has been applied freely, and in many cases rashly, too little attention having been paid to the fact that its applications really lie in the domain of those events whose occurrences may properly be compared to the drawings of balls from a bag. Hence it is necessary to exercise considerable care in connection with the literature of the subject.

Bibliography.—Bertrand, ‹Calcul des Probabilités›; De Morgan, ‹An Essay on Probabilities,› etc.; Laplace, ‹Théorie Analytique des Probabilités›; Whitworth, ‹Choice and Chance›; Williamson, ‹Integral Calculus› (Chapter on Probability).

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Pro'bate, Court of. See COURT.

Probation After Death, a doctrine favored by some modern theologians as a means of reconciling the idea of everlasting punishment with that of God's supreme mercy and the universal redemption through Jesus Christ: the doctrine differs from the doctrine of Universalism in postulating an intermediate state of the soul after death, of which Universalism knows nothing; and in rejecting the Universalist tenet that *all* will ultimately be saved. Something very like this doctrine of *post mortem* probation, and different from the Catholic doctrine regarding Purgatory, is taught by Clement of Alexandria (*Strom.* vi. 18): ‹Even if a man passes out of the flesh he must *put off his passions* ere he is able to enter the eternal dwelling.› And he speaks of the angels ‹who preside over the ascent› of souls as detaining those who have *preserved ‹any worldly attachment.›*

Proboscis or **Nose Monkey,** a rare Bornean monkey (*Nasalis larvatus*), called ‹Kahau› by the natives, and characterized by a greatly elongated nose, giving a peculiarly ludicrous appearance to the face. The general body-color is a sandy red; the tail is dark above, but light yellow beneath. These monkeys are arboreal in habits, and appear to frequent the neighborhood of streams and rivers, congregating in troops. They are closely allied to the apes of the genus *Semnopithecus*.

Pro'bus, Marcus Aurelius, Roman emperor: b. Sirmium, Pannonia, 232; d. there 282. He early attracted the notice of the Emperor Valerian, who made him tribune and soon placed him at the head of a legion. The brilliancy of his conduct in the African, Persian, Arabian, and Germanic campaigns brought him into still more prominent notice. He was made governor of all the Roman provinces in Asia by the Emperor Tacitus, and when Florianus, who succeeded his brother Tacitus, was murdered in 276 Probus was immediately proclaimed emperor by universal consent. He drove back the Franks, Alemanni, and Vandals, who had invaded Gaul; and in 277 secured the frontier wall between the Danube and the Rhine. He also freed the lands south of the Danube, Egypt and the East from devastating barbarian hordes, and concluded an advantageous peace with the Persians. He gave new dignity to the senate, populated desolate tracts in Thrace and Mœsia with barbarians (279) and paid particular attention to agriculture. He kept his soldiers actively employed in public works. Irritated at being charged with occupations which they deemed degrading, a troop engaged in draining a swamp rose in insurrection and killed him. Probus ranks among the ablest of Roman emperors, combining the qualities of a good commander and wise statesman.

Probus, Marcus Valerius, Roman grammarian: b. Berytus, Syria, second half of the 1st century A.D. He is chiefly noted for his critical revisions of the most important Latin poets, as for instance Lucretius, Horace, and Virgil. He applied to them the methods of the Alexandrian school of critics. A commentary on the Eclogues and Georgics of Virgil under his name has been preserved but is of doubtful authenticity. A biography of Persius, written by him, remains in a commentary on the works of that poet. An extant fragment of his work ‹De Notis› contains the abbreviations used for legal terms. Consult: Kubler, ‹De Probi Commentariis Virgilianis› (1881).

Procaccini, prō-kät-chē'nē, the name of a family of artists of the 16th century who under the patronage of the Borromeo family, founded a distinct school of Italian painting at Milan, as the Caracci did afterward at Bologna. The principal members of this family were (1) ERCOLE PROCACCINI: b. Bologna 1520; d. later than 1591. His works, existing at Bologna and Parma, are not remarkable for talent, but exhibit industry and care, although they are not free from the mannerism of his contemporaries. He was in great request as a teacher. (2) CAMILLO PROCACCINI, son and scholar of the former: b. Bologna 1550; d. Milan 1627. He was the most accomplished artist of this school. He profited by studying the school of the Caracci, and took Correggio and Parmegiano for his models. His imitation of them is obvious from his work but the result is equally successful. His works are distinguished for spirited composition, exquisite coloring, and devotional elevation, but are mannered. Among those at Milan are a 'Madonna and Child' in the church of Santa Maria del Carmine, and an 'Adoration of the Magi' in the Brera. (3) GIULIO CESARE PROCACCINI, brother of Camillo: b. Bologna, 1548; d. Milan 1626. He likewise strove to equal the school of the Caracci, and took for his model Correggio, whom he imitated with so much success that several of his pictures, though far from reaching the grace and harmony of that great master, have often been ascribed to him. This has been the case especially with cabinet pictures of the Fall. His works are to be met with in many galleries.

Procedure, Civil. See ACTION; CIVIL LAW; JURY.

Process, (1) in anatomy, an enlargement, such as the zygomatic process of the temporal bone, the vermiform process of the cerebellum, etc.; (2) in botany, any extension of the surface; a protrusion whether natural or monstrous; (3) in law, a term applied to the whole course of proceedings in a cause, real or personal, civil or criminal, from the original writ to the end of the suit; properly, the summons citing the party affected to appear in court at the return of the original writ. This was sometimes called original process, being founded upon the original writ; and also to distinguish it from mesne or intermediate process, which issues, pending the suit, upon some collateral interlocutory matter; as to summon witnesses, and the like.

Process of Law. See DUE PROCESS OF LAW.

Procession of the Holy Ghost, in theology the relation in the Trinity between the Father and the Holy Ghost. The Western Churches believe in what is called the «double procession» as expressed in the Nicene Creed, «Who proceedeth from the Father and the Son.» The Greek Church maintains the «single procession» and omits the words «and the Son.» See FILIOQUE.

Procession, Religious, a solemn march of the clergy and people, attended with religious ceremonies, prayers, singing, etc., in the churches, or streets of a town for the purpose of returning thanks for some divine blessing, or drawing attention to some great doctrine of the Church. The practice of holding such processions is usually said to have been introduced into the Christian Church in the reign of Constantine. The most celebrated processions which now take place in the Roman Catholic Church are those of the eucharist on Corpus Christi day, and during the week in which it occurs. They owe their origin to John xxii. The processions in honor of St. Mark and those on Candlemas and Palm Sunday are said to have been instituted by Gregory the Great. Instances of celebrations of this nature are to be found among the Jews in the Old Testament, and as a part of the symbolical worship of nature they were in use among the ancient heathens; thus they formed solemn processions about the fields, which had been sowed, and sprinkled them with holy water to increase their fertility, and to defend them from injuries. The festivals in honor of Bacchus, Ceres, Diana, and other divinities, among the Greeks and Romans, were solemnized with processions, in which the images of the gods were borne about; and similar rites are still found among most heathens. Among the Buddhists these ceremonials are especially imposing. The procession which accompanies the Emperor of China when he goes to offer sacrifices to an idol in some great pagoda is one of the most gorgerous description.

Procida, prō'chē-dä, **John of,** an Italian nobleman: b. Salerno; d. Rome 1298. The tradition which makes him the prime mover in the conspiracy alleged to have brought on the Sicilian Vespers (q.v.) has been discredited by careful investigators, but is the subject of a tragedy by James Sheridan Knowles (q.v.) (1840).

Procida (ancient PROCHYTA), (1) an island in Italy, Naples, lying nearly midway between the island of Ischia and the coast of the province of Naples. It is about three miles long, northeast to southwest, and little more than one mile broad. The principal town on the island is (2) Procida, or Castello di Procida, which stands on the southeast coast, 12 miles west of Naples. It is fortified, has a good harbor, and a considerable trade. There is a palace on the island which was occasionally used as a residence by the former kings of Naples. On festivals the women assume the Greek costume, consisting of a red upper garment with gold embroidery. It is from this island that Giovanni da Procida, the reputed originator of the massacre known by the name of the «Sicilian Vespers,» takes his name. Pop. about 15,000.

Proclamation of Emancipation. See EMANCIPATION PROCLAMATION.

Pro'clus, philosopher of the Neo-Platonic school: b. Constantinople 412; d. Athens 485. He is usually called the Lycian, because his parents came from Xanthus in Lycia. He received his first education at Alexandria from the famous Peripatetic Olympiodorus the elder, and completed it at Athens under Syrianus, who ultimately appointed him his successor, and under Asclepigenia, who had learned from her father Plutarchus the doctrines of the Orphic and Chaldaic mysteries and the united theurgic sciences. As a teacher at Athens he was very successful and not only endeavored to unite into a single whole all the philosophical schemes handed down from former ages, but made it his aim to embrace all religions by becoming filled with their spirit. Following out this maxim he composed hymns in honor of the pagan deities, defended and interpreted popular myths, and even conformed to the rites connected with their worship, and considered himself as under their protection. It was probably in consequence of this adherence to the ancient religion of Greece, in opposition to the decrees of the Christian emperors, that Proclus was compelled to withdraw from Athens. He traveled for a year in Asia to study the various religions of its inhabitants. All of them he held in reverence. On his return to Athens, where he remained till his death, he re-opened his school, but now performed his religious services in secret. By his pure morals and religious views he gave his scholars the idea that he had intimate intercourse with gods and demons, and could work miracles. He claims to resemble Plato in supporting his doctrines by an unbroken chain of reasoning, a method that had been altogether neglected by the previous Neo-Platonists. But these pretensions are not borne out by his works. A life of Proclus was written by Marinus, one of his scholars, and his successor in the school at Athens. His extant works include a 'Sketch of Astronomy,' in which he gave a short view of the systems of Hipparchus, Aristarchus, and Ptolemy; 'The Theology of Plato'; 'Principles of Theology'; 'Principles of Philosophy'; 'Commentary on the Works and Days of Hesiod'; 'Life of Homer'; etc. There is a complete edition of his works by Victor Cousin (1820–7). Consult: Kirchner, 'De Procli Neoplatonici Metaphysica' (1846).

Procon'sul and **Propræ'tor,** functionary of the ancient Roman empire, to whom the administration of the provinces was entrusted; proconsul or proprætor being one whose term of office had expired as prætor or consul. The first consul who received the title of proconsul, was Q. Publilius Philo in 327 B.C. This was done in order that he might conclude a campaign successfully begun in southern Italy. It was afterward provided by a law of C. Sempronius Gracchus that, at the consular and prætorial elections the senate should distribute the provinces into two consular and six prætorial provinces, for which the consuls and prætors should cast lots or divide them among themselves by agreement, a few days after their entrance upon their term of office, on the expiration of which they took the provinces allotted them. But in 55 B.C. it was provided by a decree of the senate that no consul or prætor should enter on the government of a province till five years after his surrender of office. As the number of provinces increased, proconsuls were appointed who had not previously held the office of consul. The duties of proconsuls or proprætors were the administration of justice, the supervision of provincial affairs, and the command of the troops. They were assisted in their duties by quæstors and legates. Within thirty days after his return to Rome the provincial governor was bound to make a report of his government. The Lex Julia in 61 B.C. further required that a copy of his report (*rationes*) should be deposited in the two chief cities of his province. He was liable to impeachment for extortion, peculation or embezzlement of the public money or for abuses in regard to the army. Notwithstanding these precautions the provinces were subjected to various oppressions and exactions. From the time of Augustus the government of some provinces was taken out of the hands of the proconsuls and proprætors, and entrusted to legates called procurators, or stewards of the imperial household, who governed under the immediate direction of the emperor. See PROVINCE; PROCURATOR.

Procopius, prō-kō'pĭ-ŭs, Byzantine historian: b. Cæsarea, Palestine, about 500 A.D.; d. Constantinople about 565 A.D. After practising as a rhetorician and advocate at Constantinople for a short time he brought himself so much into public notice that Belisarius made him his legal adviser and private secretary. He found abundant opportunity for seeking the making of history at first hand, for he accompanied Belisarius and counseled him on his most important campaigns. He was with him in Africa and Persia. About 542 he returned to Constantinople. The emperor Justinian made him senator and in 562 præfect of the city. He is the historian in chief to the reign of Justinian, to which his three most important works were devoted. These are: the 'Histories' (Historiæ) in eight books, the first two relating to the Persian war, the two following to the war with Vandals, and the rest to the Gothic war; the 'Anecdotes' (Anecdota), a secret and more personal history supplementing the more formal 'Histories'; the 'History of the Edifices, built or repaired by Justinian' (Ctismata). Doubt has been thrown on the connection of Procopius with the 'Anecdotes.' They are the repository of the scandals of Justinian's reign, filled with accusations, often of a ridiculous and improbable nature against Justinian and Theodora. On the other hand the histories are of great value, characterized by accurate personal observation and truthful presentation of conditions. The best edition of the complete works is Dindorf's. Consult: Hanry, 'Prokopiana' (1891); Dahn, 'Prokopius von Cæsarea' (1865).

Procopius, Andrew, Hussite chief: b. about 1380; d. Böhmisch-Brod 30 May 1434. He was distinguished as Procopius the Great, or the Bald, from a contemporary at times associated with him known as Procopius the Lesser. He received a good education, traveled extensively and upon his return entered the priesthood, receiving the tonsure from which was derived his nickname, the Bald. He fought with the Hussites under Ziska, and after Ziska's death was chosen commander of the Taborites, the main division of the Hussites, and quickly made himself master of a larger part of Bohemia. Defeating the German troops at Aussig in 1426, he burned that town and soon after drove the Austrians across the Danube. Burning and laying waste large portions of Austria he led his bands toward Silesia; defeated a German army near Mies (1427); and in the next two years ravaged Silesia, Hungary, and Saxony. The bands under the leadership of Procopius had by this time made the name of Hussites a terror throughout the provinces through which they pursued the armies of the Emperor Sigismund. Strife, however, ensued between the extremists, and the more moderate division known as the Calixtines, who in 1433 accepted the terms offered by the Roman Catholics. In a factional fight between the two parties Procopius was killed. In the same battle perished Procopius the Lesser, leader of a section of the Hussites called the Orphans, which had co-operated with the Taborites since 1427.

Procrustes, prō-krŭs'tēz, Attic robber, surnamed Polypemon, or Damastes. He possessed a bed upon which he forced his guests to sleep, and if they were too tall to fit it he had their limbs chopped off, whereas, were they too short he had them stretched. The monster was outwitted by Theseus, who made him suffer on the same bed and slew him on the Cephissus in Attica. The “bed of Procrustes” has thus become a proverbial expression. Another version represents him as having two beds, one short and one long, the first for tall visitors and the second for short ones.

Procter, prŏk'tėr, **Adelaide Anne,** English poet, daughter of Bryan Waller Procter (q.v.): b. London 30 Oct. 1825; d. there 3 Feb. 1864. Her first verses were published in ‘Household Words’ in 1853 under the pseudonym “Mary Berwick,” and attracted much attention, gaining in particular the favorable notice of Dickens, who did much to aid the young poet. While her work is not great it is marked by deep feeling and tenderness. Her poems with few exceptions first appeared in either ‘Household Words’ or ‘All the Year Round.’ She became a Roman Catholic in 1851. Her collected poems were published under the title ‘Legends and Lyrics’ (1858), and a subsequent edition (1866) contains a biographical sketch of the author by Charles Dickens. Many of her poems have received a musical setting, the most famous being ‘The Lost Chord,’ which was set to music by Sir Arthur Sullivan.

Procter, Bryan Waller, “BARRY CORNWALL,” English poet: b. Leeds 21 Nov. 1787; d. London 5 Oct. 1874. He was educated at Harrow, subsequently studied law in London, and in 1831 was called to the bar of Gray's Inn. For many years he held the office of commissioner of lunacy, resigning in 1860. His first appearance in literature was in 1819, when he published ‘Dramatic Scenes and Other Poems,’ under the pseudonym of “Barry Cornwall,” which he afterward retained. Later works were: ‘A Sicilian Story’; ‘Marcian Colonna’; ‘Mirandola’ (1821), a tragedy performed with great success at Covent Garden; ‘The Flood in Thessaly’ (1823); ‘English Songs and Other Small Poems.’ His prose includes ‘Effigies Poeticæ, or the Portraits of the British Poets’; ‘Life of Edmund Kean’; ‘Essays and Tales’ (1853); ‘Memoir of Charles Lamb’ (1866). He will be longest remembered as a song writer, but even so his work has been somewhat overrated. Consult: Patmore, ‘Life of B. W. Procter’ (1877).

Procter, John Robert, American civil service reformer: b. Mason County, Ky., 16 March 1844; d. Washington, D. C., 12 Dec. 1903. He was educated at the University of Pennsylvania, but left there to join the Confederate army in 1864. In 1873 he became assistant in the Kentucky geological survey, and in 1880 State geologist. In this office he was brought into contact with the spoils system, to which his opposition was so uncompromising that he finally lost his position in 1893. In the same year, however, he was appointed president of the Civil Service Commission, a post which he held till his death. His criticism of the spoils system was based not only on its evil moral and social effects, but also on its absurdity as a method of conducting business, and this view he constantly presented most effectively. His work as president of the commission was the means of increasing the effectiveness of the civil service, and of gaining for it recognition in political life.

Proctor, prŏk'tŏr, **Alexander Phimistes,** American sculptor: b. Ontario, Canada, 27 Sept. 1862. He was the pupil of Puesch and Ingalbert at Paris, and was awarded the Rinehart Paris scholarship. Not only as a producing sculptor but as a critic of sculpture his reputation is high and he was appointed a member of the sculpture jury at the Paris Exposition of 1900 and at the Pan-American Exposition of 1901, and is a member of the Art Commission appointed by Mayor Low in 1903. Among his works were the quadriga which he furnished for the United States pavilion at the Paris Exposition of 1900, which was much admired. Others of his sculptures may be seen in the parks of New York, Denver, and Pittsfield.

Proctor, Edna Dean, American poet: b. Henniker, N. H., 10 Oct. 1838. She was educated in Concord, has traveled extensively in Europe, and has achieved a considerable reputation as a poet. Her most notable poems are: ‘Heroes’ and ‘Shenandoah.’ Among her works are: ‘Poems’ (1866); ‘A Russian Journey’ (1872); ‘The Song of the Ancient People’ (1892); ‘Mountain Maid and Other Poems of New Hampshire’ (1900).

Proctor, Redfield, American politician: b. 1 June 1831; d. 4 March 1908. He was graduated from Dartmouth in 1851, and from the Albany Law School in 1859. He practised law for two years, and in 1861 entered the Federal army as lieutenant; was soon promoted major and then colonel, and commanded a regiment at Gettysburg. After a few years' law practice he devoted himself to business, acquiring large interests in marble quarries in Vermont. He began political life as a Republican member of the lower house of the Vermont legislature, being first elected to that body in 1867, and again in 1868 and 1888; he was a member and president *pro tem.* of the State senate in 1874 and 1875; in 1876 he was elected lieutenant-governor, and in 1878 governor of the State. During his administration he brought about several reforms in the State finances and system of taxation. In 1888 he was chairman of the Vermont delegation to the Republican National Convention, and again in 1896. In 1889 he was appointed secretary of war by President Harrison, and gave especial attention to the improvement of coast and border defense. In 1891 he resigned his secretaryship to accept the appointment to the United States Senate for the unexpired term of Senator Edmunds, resigned, and in 1892 was elected to the Senate for the six years' term. In 1898 and 1904 he was re-elected. In 1898 he visited Cuba to investigate conditions in the island, and on his return delivered a speech in the Senate in regard to the reconcentrados, which aroused the attention of the

whole country. The facts presented by him were also influential in determining the policy of intervention in Cuba by the United States.

Proctor, Richard Anthony, English astronomer: b. Chelsea 23 March 1837; d. New York 12 Sept. 1888. He was educated at King's College, London and Cambridge, and began to read for the bar, but in 1863 took up with enthusiasm the study of astronomy and mathematics. He taught mathematics for a time at a private military school at Woolwich, and in 1873 made a lecturing tour in this country. As a lecturer he became at once popular, having in eminent degree the gift of lucid exposition. A second tour to the United States in 1879 and a tour to Australia were followed by his settling at St. Joseph, Mo., in 1884. In 1887 he returned to Florida. He did much to popularize astronomy. His works include: 'Saturn and His System' (1865); 'Handbook of the Stars' (1866); 'Half-hours with the Telescope' (1868); 'Half-hours with the Stars'; 'Other Worlds Than Ours' (1870); 'Light Science for Leisure Hours' (1871); 'The Moon' (1873); 'The Transits of Venus' (1874); 'The Cycloid and Cycloid Curves'; several 'Star Atlases'; 'The Universe of Stars' (1878); 'The Romance of Astronomy' (1880); 'Hereditary Traits' (1882); 'The Great Pyramid' (1883); 'Nature Studies' (1883).

Proctor (Lat., *procurator*), one who acts on another's behalf. It has in England these special significations: (1) In the convocations of the two ecclesiastical provinces, Canterbury and York, respectively, the official who represents the lower clergy and the capitular bodies of cathedral and collegiate churches; (2) a person who manages another's cause in an ecclesiastical court or in a court of admiralty; owing to recent changes in the administration of law, the business formerly confined to proctors may now be conducted by solicitors; (3) in the universities of Oxford and Cambridge, two proctors in each are charged with the duty of preserving the peace and repressing disorder among the students; to this end they are empowered to inflict summary punishment and have command of a constabulary force. The proctors must be masters of arts; they are chosen by the several colleges in turn.

Proc'urator, among the ancient Romans, an agent, steward, or overseer of an estate; at a later period the title of a provincial officer (see PROVINCE and PROCONSUL), who managed the revenue. In some of the small provinces, or in a part of a large province, the procurator discharged the office of a governor, and had the power of punishing capitally, as was the case with Pontius Pilate in Judæa, which was attached to the province of Syria.

Procurator or proctor, in monasteries, is the conventual to whom is entrusted the care of the temporal concerns.

Procurator di San Marco was the title of the chief officers or senators in the Venetian republic. Besides the nine actual *procuratori,* from among whom the doge was chosen, there were also many titular procurators, who paid a great sum for this title, which was much coveted by the Venetian patricians on account of the rank it conferred.

Procurator-Fiscal, the public prosecutor in criminal cases which come up in Scotland before the sheriff, magistrates, or justices of the peace belonging to his district. Only when the public interest is concerned must he originate a prosecution; and when complaint is made by a person in a case in which the private interest of the complainant is rather at stake than the public interest, the procurator-fiscal must merely give his concurrence to the prosecution, and not institute the proceedings. He may, however, act as the complainant's agent; but even when he does so, if he only gives his concurrence, he is not liable to an action for malicious prosecution.

Prod'icus, Greek Sophist: he came from Julis in the island of Ceos, and was a contemporary of Socrates. He is only known as the author of an apologue of 'Hercules and the Two Paths,' quoted by Xenophon, in which the young hero chooses the hard path of duty, and turns his back on the flowery but dangerous path of pleasure.

Production, Cost of. See POLITICAL ECONOMY.

Prœtus, prē'tŭs, in Greek mythology, king of Tiryns. According to Ovid he founded the kingdom after making peace with his twin-brother, Acrisius, who had driven him out of Argos. The tragic legend concerning him deals chiefly with the fate of his three daughters, the Prœtidæ. These, rendered mad by Hera or Dionysus, wandered through the Peloponnesus, in time communicating their frenzy to other women, so that they killed their children. One of the three sisters died, the other two were healed by the seer Melampus, who married one and was given a share in the kingdom, his brother, Bias, receiving also a share and marrying the other daughter.

Pro'fert, in law, an exhibition of a record or paper in open court. When either party alleges any deed, he is generally obliged, by a rule of pleading, to make profert of such deed; that is, to produce it in court simultaneously with the pleading in which it is alleged.

Professional Education, the special training which enables a man to use his knowledge of science in the best way, in order to increase power of production, and to limit time, force, and expenses. The knowledge of science, the liberal education, the general culture to which a study of the arts and sciences contributes and for which such study is essential, should precede the special training. The need of professional education for the most intelligent and effective work in the professions, and also in the trades, is generally recognized. The governments of all civilized countries have taken cognizance of this fact, and have either through the general governments or through subordinate departments encouraged and sometimes enforced professional education for certain professions, as medicine, pharmacy, law, teaching, etc. The general rule for admission to distinctively professional schools is, that satisfactory proof of a liberal education must be furnished. In Europe, the general governments of France and Germany regulate the requirements for professional schools. In Italy such schools are nearly all in charge of the minister of agriculture and commerce, and are supported by the united contributions of the state, the provinces, the communes, the chamber of commerce, and the association of mechanics. In Italy and in other countries in Europe, "professional schools" include schools for instruction in trades, industries, and occupations. The professional schools of the British Isles are almost wholly independent of the general government. In France the secondary schools form with the universities a system of liberal education, crowned by specialized training for the learned professions. The apprenticeship system in the trades is being replaced to a large extent by the special training schools. For entrance to the government professional schools or the professional courses in the universities, the bachelor's degree is required. The government has (1902) four schools furnishing complete courses, and 12 preparatory schools for medical and pharmaceutical science, the graduates of which are examined by the university professors. There are also government law schools. In Germany, in 1902, there were graduates in schools under government supervision, in medicine 7,341; in law, 11,335. In Great Britain and Ireland professional education is recognized in the curriculum of Cambridge, Oxford, the University of Dublin, the Royal University of Ireland, the Catholic University of Ireland, the four universities of Scotland, the University of Wales, London, Victoria, and Durham universities, provincial medical schools, normal schools (q.v.), trade schools, and numerous private institutions. In Spain special attention is given to normal schools, schools of medicine, and law. In the Netherlands there is a large proportion of professional schools. In countries of Asia and South America, where the governments have any control over education, professional education in law and medicine has received attention. The theological schools are generally supported by the churches or by generous endowments. In countries where a state church has been established, theological schools of the same church are supported, at least in part, by the government. The need of professional education is becoming more apparent as the work of the world becomes more and more specialized. For other departments, see EDUCATION, PROFESSIONAL, IN AMERICA; SCHOOLS, NORMAL AND TRAINING, and EDUCATION, in articles on different countries. Consult: Reports of the U. S. Commissioner of Education.

Professional Woman's League, The, an association founded in New York in 1893, and composed of women engaged in dramatic, musical, literary, artistic, and scientific pursuits. The dues are $5.50 per annum, the league holds a bazaar each year, and gives occasional entertainments during the winter season.

Professor, The, a novel by Charlotte Brontë, published in 1857. It was the first fiction that she produced, but it failed to find a publisher until after her death. "The plot in itself is of no great interest," remarks Mrs. Gaskell, the biographer of Charlotte Brontë, but "she never excelled one or two sketches of portraits which she has given in 'The Professor,' nor, in grace of womanhood, ever surpassed one of the female characters there described."

Professor at the Breakfast Table, The, a work by Oliver Wendell Holmes, first published serially in the 'Atlantic Monthly' in 1859. It furnishes a sequel to the well-known 'Autocrat of the Breakfast Table,' which it resembles in tone and construction.

Profit Sharing, a method by which wage-earners receive a share of the profits of an industry in addition to wages. Strictly speaking, profit sharing implies that the bonus shall be given to workmen individually; but benefits and insurance, social and educational funds maintained out of the profits of a business are modified forms of profit sharing. Many systems of profit sharing also provide for the employees obtaining share in the capital stock on special terms, thus becoming part owners of the industry. Profit sharing differs from co-operation, in that it is not democratic; both the initiative in establishing a system of profit sharing, and the control of the industry rests with the employer. It is regarded, however, as a step toward co-operation. The arguments advanced in favor of profit sharing are: (1) Its justice, inasmuch as labor is equally necessary with capital to the welfare and success of an industry, it should justly receive a part of the profits; (2) its practical effect; it tends to interest employees in their work, to increase their efficiency and their care of property. There are two lines of opposition to profit sharing: (1) From the employers, who claim that it is unjust that labor should share in the profits, when it does not share in the loss or risk of the business; and that profit sharing does not necessarily result in increased efficiency; and (2) from the workmen who claim that their freedom is restricted, especially as in many instances a long term of employment and sometimes restriction of labor organization are involved in a profit-sharing system; and that they obtain no compensating share in the management or control of the industry. Profit sharing has been successful in many industries, especially where the labor is skilled, and wages large in proportion to total cost of production; on the other hand, many attempts to establish a profit-sharing system have failed, owing sometimes to industrial depression, sometimes to a trial too short to give fair results, and sometimes to change in management. In the United States between 1889 and 1896, 50 firms had made trial of profit sharing; in the latter year, only 12 continued it permanently, and five had abandoned it temporarily; in 1900, there were 23 firms with a system of profit sharing, 12 of which had adopted it within the year 1899–1900.

France outranks other nations in the number and importance of successful profit-sharing enterprises; there being over 100 in 1900. Among the more important ones are Le Claire's (painter), the Belle Lamaire, the Godin Familistère at Guise, and the Bon Marché (q.v.). Great Britain ranks next, with 95 firms having a system of profit sharing. Among the most important profit-sharing establishments of the United States are the Nelson Manufacturing Company of St. Louis, Mo., and the Proctor & Gamble Company of Ivorydale, Ohio. The Nelson Company established its system in 1886, which, besides the direct sharing in profits by the employees, provides for the payment of sickness and accident benefits by the company as a part of the costs of the business; the employees are also encouraged to buy stock in the company. In 1896 an agreement was made by which the employees of the cabinet-making shop were to gradually purchase and take the management of that department; by 1902 they had sole control. The Proctor & Gamble Company introduced profit sharing in 1887; the arrangement was that the employees should receive a share in the net profits in the proportion that wages bore to the whole cost of production. The fact that the employees were largely unskilled labor with low wages, and received the new arrangement with indifference made the management of the system particularly difficult. An improvement was made by classifying the employees into four groups in regard to interest in work, excellence of work, and care of machinery and tools; the best in accordance with this classification received double the regular dividend, the second group, including the greater number of the employees, the regular dividend, the third group one half the dividend, and the fourth none at all. In 1903, the United States Steel Corporation adopted direct profit sharing for its more responsible employees, and a system whereby any of its employees may acquire stock on easy terms, and as long as they remain in the employ of the company, may receive a bonus of $5 a year extra for each share after the first five years. Later in the same year the Mann Edged Tool Company of Lewiston, Pa., announced a division of all profits above 8 per cent among employees who had been with the company at least four months, in proportion to their earnings. This plan involved a «disconnection with any labor organization outside their own.»

Consult: Gilman, ‘Industrial Partnership or Profit Sharing’ (1890); ‘Profit Sharing Between Employer and Employee’ (1891); ‘A Dividend to Labor’ (1899); Taylor, ‘Profit Sharing Between Capital and Labor’ (1886); and Wright, ‘Profit Sharing’ (1886).

Progress, the advancement of the world, moral, mental, and material, as exhibited in history. Physical science, which has so recently demonstrated the gradual improvement of material types in the animal and vegetable world, has compelled metaphysical speculation to conform its general principles to the axioms formulated by physical observation and experiment. The result of science, of historical inquiry, of inductive activity in every area of investigation may favor neither optimism nor pessimism. They have brought into philosophy a third term, and that is meliorism, a term employed to denote a doctrine so firmly based on fact that none can controvert it. Meliorism embodies the truth that as far as human experience and observation can extend there has been improvement in things, progress in the universe, advancement in the world. Pessimism becomes a contradiction in terms; for the physicist in his laboratory, the historian in his study, the sociologist in his inquiry among men, declares that things have been once worse than they are now, and that from the flower in the field to the beast in the stall, and from the beast in the stall to the working man, the ruler and the general condition of nations, things have been growing better. The lapse of centuries shows a sensible amelioration in the lot of humanity. The slave has been enfranchised, woman has been raised and enlightened, the rights of labor have been more and more recognized. These, however, are only social and political examples of that universal amelioration and progress by which a nebula is changed into a star, and a star into a peopled and conscious world. Meliorism is the principle that underlies all existence, organic or inorganic and comprehends in its widely extending connotation the discovery of drugs that abolish pain, of economic institutions that diminish poverty, of intellectual institutions that make ignorance and incompetency more and more rare, and of tolerance and enlightenment which give more and more freedom to the creeds, tastes, and idiosyncrasies of individual men. In whatever direction we look over the field of human activity we see this improvement manifesting itself, and the phenomena which are the basis of meliorism furnish the best argument for that hopeful optimism which, as many believe, alone can give the mind a philosophical creed that renders life tolerable.

Meliorism is the doctrine of the positivist, because it is no metaphysical system which interprets facts by *a priori* assumption; it is simply an induction from a summary of those facts which physical science has most recently set forth as the proud results of the newest, the most unbiased, and the most uncontrovertible deductions from experiment and observation, in the whole world of material, social, and political phenomena.

Progress and Poverty, a famous work by Henry George, written in 1877-9. The MS. was declined by publishers till the author, a practical printer, had the plates made, and it was then brought out in 1879. The author seeks in this work to solve a problem and prescribe a remedy. The problem is: «Why, in the midst of a marvelous progress, is grinding poverty on the increase?» The remedy is to nationalize the land,— make it public property; leaving that already in use in the possession of those holding it, but confiscating the rent and abolishing all other forms of taxation.

Progression, in mathematics, a series or sequence of terms such that each quantity bears the same mathematical relation to the preceding. This relation may be either that of a difference or of a ratio; the first case is that of the *arithmetical progression*, the second that of the *geometrical series*.

In an arithmetical series each term is derived from the preceding by adding to it a constant, called the difference, which may have a plus sign or a minus sign, so that the series may either increase or decrease. In the accepted notation of the arithmetical progression, a is the first term, n the number of terms, d the difference, and l the last term. The value of the last term or of any (the nth) term may be determined from the formula, $l = a + (n - 1)d$, which is merely a notational statement of the evident fact that the coefficient of d in any term will be less by one than the number of term, so that the nth term must be the sum of the first term and of the difference taken $(n - 1)$ times. Letting s stand for the sum of n terms we may write in ascending or descending order:

$$s = a + (a + d) + (a + 2d) + \ldots\ldots + (l - d) + l, \text{ or } s = l + (l - d) + (l - 2d) + \ldots\ldots + (a + d) + a.$$

Adding these two equations we get the equation, $2s = (a+l) + (a+l) + (a+l) + \ldots + (a+l) + (a+l)$, or $2s = n\,(a+l)$, it being evident that the factor $(a+l)$ occurs n times in the second term of the preceding equation. The formula for the sum will then be $s = \frac{n}{2}(a+l)$. Hence, if three of data are given as to an arithmetical series, that is, three of a, d, n, l, s, the fourth (and the fifth, usually) can be found by the regular processes of algebra. Moreover the *arithmetical mean* between two numbers, being the mid-term in a series in which the number of terms is odd, will be one half the sum of the two numbers.

A geometrical progression is a series in which each successive term is derived from the preceding by multiplying it by a constant, called the ratio, which may be less or greater than unity, so that the series may decrease or increase, or may be either plus or minus, so that the terms may be either similar or constantly changing in sign. In the accepted notation of the geometrical progression, a is the first term, r the common ratio, l the last (or nth) term and s the sum of the series of n terms. The formula for l, the nth term, since the exponent of r increases by one in each term will be $l = ar^{n-1}$.

To derive the formula for the sum of n terms, get the difference of the two self-evident equations,

$$s = a + ar + ar^2 + \ldots + ar^{n-1}, \quad \text{and}$$
$$rs = ar + ar^2 + \ldots + ar^{n-1} + ar^n.$$

The difference is $rs - s = ar^n - a$, or $(r-1)\,s = a\,(r^n-1)$. The formula then is $s = \frac{a(r^n-1),}{r-1}$ or $\frac{rl-a}{r-1}$ With any three of the quantities given in these two formulas the other two may be derived by the use of quadratic equations (and in one instance of logarithms). An interesting variation of the problem of the summation of a geometric series is to find the value of a repeating decimal or repetend; as, for example, to find the value of $.545454\ldots$ (or $.\dot{5}\dot{4}$). Here $a = .54$, $r = .01$, and $n = \alpha$. Because of the infinite value of n, the value of l is practically zero; hence in the formula for the sum, $\frac{rl-a,}{r-1}$, rl becomes negligible, and the formula takes the form $\frac{-a}{r-1}$ or $\frac{a}{1-r}$. Substituting the values above we have $\frac{.54}{.1-.01} = \frac{6}{.11}$.

A *harmonical progression* is a series in which the reciprocals of the terms form an arithmetical series. Any problem relating to harmonical progressions may therefore be treated as problems in arithmetical progression by the mere inversion of each term. See SERIES.

Progressives, The. The term "Progressives," or more popularly, "Insurgents," was applied originally to those Republican Congressmen who contended that The House should itself elect the Committee on Rules, instead of allowing the Speaker to appoint the committee. These efforts, continued through several years, were finally successful on 17 March 1910, when such a change was ordered and the committee enlarged from five to ten members.

The name "Progressives" then assumed new importance and was applied especially to members of the Republican party in both branches of Congress who took issue with the administration of President Taft on several questions, notably the tariff, or who took what was generally considered advanced or "progressive" ground on other leading public measures. They have therefore added to their repertoire of policies and achievements, and been considered sponsors for, or at least leading advocates of, many important public measures. The success of the Progressive movement not only almost reversed the political control of Congress in the elections of 1910, but paved the way for the formation of the Progressive Party (q.v.) in 1912, and largely shaped the Democratic platform in the same year.

Progressive Party, The. A new political party was organized at a national convention held at Chicago, Ill., 5–7 August 1912, and unanimously placed in nomination for the presidency and vice-presidency respectively, Theodore Roosevelt, of New York, and Hiram W. Johnson, of California. The objects of the Progressive Party, as set forth in the incorporation papers issued at Albany, N. Y., on 31 July 1912, are as follows: "To promote by educational means and political action, social and industrial justice and political liberty in the State and Nation; to advocate such legislation and administration as will secure to the people the effective control of all of the agencies of their government; to promote such legislation as is demanded by the modern industrial revolution, and which will secure a better and more equitable diffusion of prosperity; and to take such political action as will result in the election to public office of candidates who are in accord with the policies and objects of the organization; and further, to unite in a common movement all associations and organizations formed for like purposes throughout the State of New York and the United States of America." The preamble of the platform of the Progressive Party states that "The conscience of the people in a time of grave National problems has called into being a new party, born of the Nation's awakened sense of justice."

The Platform.—The main recommendations of the platform are as follows:

Preferential primaries, direct election of United States Senators, the short ballot, the initiative, referendum and recall.

A more expeditious method of amending the Federal Constitution.

National jurisdiction on those problems which have expanded beyond reach of the individual States.

Social and industrial justice to be secured by legislation for the prevention of industrial accidents, occupational diseases, overwork, involuntary unemployment; the prohibition of child labor; the minimum wage for working women, with prohibition of night work for women and an eight-hour day for the same sex; one day's rest in seven for all wage workers; the abolition of the convict contract labor system; protection against the hazards of sickness, irregular employment and old age through a system of social insurance; the organization of workers, men and women, as a means of protecting their interests.

National regulation of interstate corporations through a strong Federal administrative commission.

The appointment of diplomatic and consular officers solely with a view to their special fitness and worth.

A protective tariff to equalize conditions of competition between the United States and foreign countries, both for the farmer and manufacturer, and which shall maintain for labor an adequate standard of living; an immediate downward revision; a non-partisan scientific tariff commission; the repeal of the Canadian reciprocity act.

Full and immediate inquiry into the high cost of living.

The improvement of the national currency system.

Conservation and national control of natural resources.

Development of our rivers, especially the Mississippi and its tributaries.

Use of the Panama Canal for American benefit, free from control of American railroads, and American coastwise trade to be exempt from tolls.

Public ownership of the natural resources of Alaska.

Equal suffrage to men and women.

Limitation of campaign contributions and expenditures.

Registration of lobbyists; prohibition of Federal appointees from holding office in state or national political organizations.

Restriction of the power of the courts.

Restriction as to injunctions and contempt proceedings in labor disputes.

Establishment of a Department of Labor.

The reëstablishment of the Country Life Commission.

Revision of the patent law.

Power to value the physical property of railroads; abolition of the Commerce Court.

Construction of national highways; extension of the rural delivery system.

A graduated inheritance tax, and ratification of the income tax amendment to the Constitution.

Judicial and other peaceful means for settling international differences; an international agreement for the limitation of naval forces.

Protection of the rights of American citizenship at home and abroad.

Increased care of our immigrant population.

A wise and just policy of pensioning American soldiers.

Creation of a parcels post.

Readjustment of the business methods of the national government.

Protection against worthless investments.

Prohibition Party, a political party in the United States, organized in 1869 for the securing of certain reforms in government, among which the prohibition of the alcoholic drink traffic is supremely important. The attitude of the party in its formation and in its repeated declarations upon the traffic may be fairly stated in the following resolution incorporated into its National platform of 1892:

(1) The liquor traffic is a foe to civilization, the arch enemy of popular government, and a public nuisance. It is the citadel of the forces that corrupt politics, promote poverty and crime, degrade the Nation's home life, thwart the will of the people and deliver our country into the hands of rapacious class interests. All laws that, under the guise of regulation, legalize and protect this traffic, or make the Government share in its ill-gotten gains, are "vicious in principle, and powerless as a remedy." We declare anew for the entire suppression of the manufacture, sale, importation, exportation, and transportation of alcoholic liquors as a beverage by Federal and State legislation. The full powers of Government should be exerted to secure this result. No party that fails to recognize the dominant nature of this issue in American politics deserves the support of the people.

The causes that impelled the organization of the Prohibition party may be briefly summarized;

1. Prior to the Civil War, the policy of taxation license and revenues in the manufacture and sale of alcoholic beverages in the United States had not been formulated into State and Federal law. But the need of greatly increased revenues to repair the financial waste and damage of the war was made the plausible pretext for imposing a heavy Federal tax on the manufacture of distilled and fermented liquors. This immense levy, comprising nearly one third of the total direct revenues accruing annually to our government, carried with it the nation's implied and pledged guaranty of protection to the brewery and distillery. Logically, their increased product would have government encouragement in expanding Federal revenues, and the cost of the tax was added to the original price of the alcoholic product, and was paid by the consumer. In the era of speculation and good prices immediately following the war, the modern saloon found the opportune time of its inception and evolution. Habits of dissipation and lax public morals engendered by the war would facilitate its development. Added to these was the heavy foreign immigration of that period, bringing to our shores from Continental Europe, its well nigh universal habit of wine, beer and ale drinking. The State, and the lesser corporations, following the government's initiative, established a system of local tax or license upon the traffic large enough to appeal to the cupidity of the tax payer. Thus the modern saloon, buttressed in protective legislation, the popular dispensary of alcoholic beverages to its numerous devotees, and grounded in the immense wealth of the traffic, has become a powerful and all controlling political factor in the moral and social destinies of the nation.

2. The organization of the liquor trade itself for offensive and defensive warfare against all prohibitory legislation would impel the formation of a party clearly opposed to their purposes. This trade organization formed during the Civil War, resolved that they would secure if possible the repeal of all existing prohibitory laws, or failing in this endeavor, would prevent their legal enforcement. The Brewers' Congress of 1867 declared they would sustain no candidate of whatever party in any election who was in any way disposed toward total abstinence. The few States that had outlawed the drink traffic within their jurisdiction found it exceedingly difficult if not usually impossible, to enforce the prohibitory law, inasmuch as the officers charged with this duty were either the willing tools of the traffic, or in personal habit and party fealty opposed to the policy of prohibition.

3. The final cause for organizing a Prohibition party was found in the attitude of the Republican and Democratic parties. In national policy neither would declare for prohibition, and both had been arraigned for complicity with the drink traffic. The law of license prevailed in regulating the traffic in the Federal territories and in the District of Columbia, all of which were under direct Congressional control and supervision. The same Federal law of permission applied to the States, even to those that had adopted statutory or constitutional prohibition. By the law of interstate commerce, liquors could be shipped under certain regulations into States where their manufacture and sale had been prohibited. It was believed that with this conflict of State and Federal authority in dealing with the drink traffic, and a fealty to ruling political parties that required cheerful and loyal acquiescence to both a national policy of license and a local law of prohibition, that a new party was demanded which was unreservedly committed to the complete overthrow of the legalized drink traffic in state and nation.

At a session of the Grand Lodge of the Independent Order of Good Templars held at Oswego, N. Y., 27 May 1869, a meeting of those favoring independent political action was held, and a committee appointed to issue a call for a national convention to organize a Prohibition party. In response to this call, nearly 500 delegates from 20 States met in Farwell Hall, Chicago, 1 Sept. 1869, adopted a platform of principles, and assumed the name of the National Prohibition Party. The first national nominating convention was held in Columbus, Ohio, 22 Feb. 1872. The platform declared first for entire and absolute prohibition. It also included decisive declarations on the questions of public service, finance, interstate commerce, tariff, labor, education, immigration, and favored equal suffrage for women. Thus in the inception of the party, and for 20 years following in each succeeding nominating convention, there was a full platform of principles set forth, embodying the party conviction on all the leading and ever recurring questions of national issue. In the national convention held at Cincinnati in 1892, a determined effort was made on the part of some to abandon the broad platform, or at least so to minimize its utterances that the only condition of full party fellowship required should be agreement in the suppression of the drink traffic. Although this action was opposed by a strong minority of the convention, the advocates of the measure won a substantial victory in the adoption of the 15th resolution of the platform known as the «dominant issue plank» which declares as follows:

> (15) Recognizing and declaring that Prohibition of the liquor traffic has become the dominant issue in national politics, we invite to full party fellowship all those who, on this one dominant issue, are with us agreed, in the full belief that this party can and will remove sectional differences, promote national unity, and insure the best welfare of our entire land.

This action was the entering wedge in a party division which culminated four years later at Pittsburg. In March 1895 twenty-one members of the National Committee issued an address to the party, protesting against the utterances of its Executive Committee wherein an apparent effort was made to «abrogate, or at least disparage, some planks of the National platform, and to create the impression that the party does not consider itself pledged in political faith, fealty, and effort to other than the prohibition plank of its declaration of principles made at Cincinnati in 1892.»

In the National Convention held at Pittsburg, Pa., in May 1896, the contest for a narrow gauge platform was renewed. The Committee on Platform presented both majority and minority reports. After a long and quite acrimonious discussion confined mainly to the proposed suffrage and financial planks of the platform, and after the financial plank proposed by the minority had been rejected by the Convention in a majority of 40 out of a full total vote of 814 votes cast, a substitute was offered for the whole platform, reported by the Resolutions Committee, and was upon motion adopted. This was known as the «Single Issue» platform, and declared as follows:

> The Prohibition Party in national convention assembled declares its firm conviction that the manufacture, exportation, importation and sale of alcoholic beverages has produced such commercial, industrial, social and political wrongs, and is now so threatening the perpetuity of all our social and political institutions that the suppression of the same by a national party organized therefor is the greatest object to be accomplished by the voters of our country and is of such importance that it of right ought to control the political action of all of our patriotic citizens until such suppression is accomplished. The urgency of this cause demands the union without further delay of all citizens who desire the prohibition of the liquor traffic.
>
> *Therefore*, be it resolved, that we favor the legal prohibition by state and national legislation of the exportation, interstate transportation and sale of alcoholic beverages; that we declare our purpose to organize and unite all the friends of prohibition into one party, and in order to accomplish this end we deem it but right to leave every Prohibitionist the freedom of his own convictions upon all other political questions, as the changes occasioned by prohibition and the welfare of the whole people shall demand.

At the evening and closing session of the convention, nominations were made as follows: For President, Joshua Levering of Maryland. For Vice-President, Hale Johnson of Illinois. Prior to this action, the «broad gauge» delegates withdrew from the convention, held an informal caucus, and repairing to Braun's Hall, effected a new organization known as the «National» party. On a roll call of membership, 299 representatives from 27 States responded. A broad platform was adopted, declaring for the following among other reforms named:

Prohibition of the drink traffic; equal suffrage; government issue of all money with free coinage, and government ownership and operating of «Railroads, telegraphs and other natural monopolies.»

In candidates the convention selected for President, Charles E. Bentley of Nebraska, and for Vice-President, James H. Southgate of North Carolina. At the election in November the National Party candidates received 13,955 votes. The subjoined table gives the names of the Presidential candidates of the Prohibition Party from its beginning, the year in which they were nominated, and the whole number of votes cast for each:—

Year nominated	For President	For Vice-President	Votes cast
1872	James Black	John Russell	5,607
1876	Green Clay Smith	Gideon T. Stewart	9,737
1880	Neal Dow	H. A. Thompson	10,336
1884	John P. St. John	William Daniel	150,626
1888	Clinton B. Fisk	John A. Brooks	249,945
1892	John Bidwell	James B. Cranfill	270,813
1896	Joshua Levering	Hale Johnson	130,753
1900	John G. Wooley	Henry B. Metcalf	207,820
1904	Silas C. Swallow	George W. Carroll	258,838
1908	Eugene W. Chapin	Aaron S. Watkins	253,840

The «Single Issue» platform was reaffirmed in 1900. The States now under full or modified prohibitory law are Maine, Iowa, Kansas and North Dakota. In South Carolina the State regulates the sale of liquors by a so-called «Dispensary Law.» In Georgia, Texas and other Southern States, under the provisions of «local options,» many counties and large areas of territory are under local prohibitory law. The same is also true in limited area in other States north and west. The National organ of the Prohibition party is 'The New Voice,' published in Chicago. See also LOCAL OPTION.

CHARLES E. BENTLEY,
Presidential Candidate, 1896.

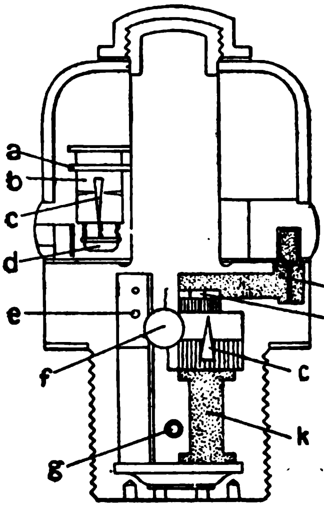
Prohibitive Duties, the taxes or system of tariff imposed by a government on imported articles for the protection and encouragement of domestic industries, or as a retaliatory measure in the case of a nation thus discriminating against the productions of another, or favoring those of other countries.

Protective duties in their various mutations present problems of great commercial and political importance, affecting, as they do, the value of the markets of one country in regard to those of another. Of the four great commercial countries of the world, the United States at present has a general system of protective duties applied to imports without discrimination as to their origin; Germany has a multiple system composed of a general and a conventional schedule; France has a multiple tariff consisting of a maximum schedule; while Great Britain is practically a free-trading country without protective duties.

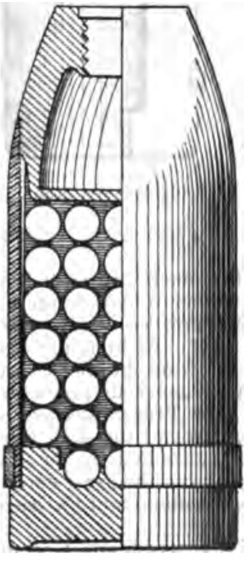
These taxes are enacted by the legislative branch of each government, and, in the «general system» as employed in the United States, recognizes the needs of the home country solely, and takes account of foreign commercial relations only, when the latter are in harmony with home interests. The system in use in Germany, that of «general» and «conventional» duties, makes a distinction between goods which come from different nations on the basis of mutual concessions and a general understanding, usually ratified by treaties, in which some countries receive the «most favored nation» or «conventional duties» treatment, while to others not so favored, the original or «general» table of duties is applied. The multiple or double-tariff system of maximum and minimum impositions also consists in having two rates of duties for most dutiable articles. In its application the maximum rate corresponds to the «general» table described above, while the minimum rate is imposed on the «most favored nations.» The difference arises from the double-tariff system being framed by the legislature of a country, and not by international treaty, and the two tables exhibit the exact limits in which to negotiate commercial treaties, should occasion arise.

The agitation against heavy protective duties has been continuous, and led to the appointment in 1882 of a tariff commission, which recommended important revisions, some of which were embodied in the act of 1883. The McKinley tariff act was passed in 1890; the Wilson act in 1894, and the Dingley act in 1897. The question has been one of great political importance, and is still (1905) claiming the attention of Congress. See Free Trade; Protection; United States — History of the Tariff.

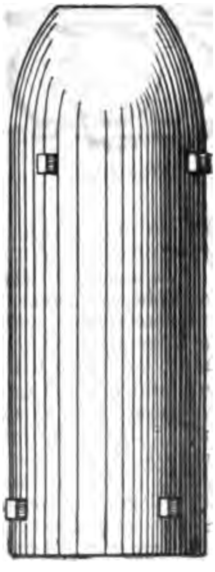
Projectiles (from Lat. *projectare*, to thrust forward; Fr. *projecter*, to project). In its broadest sense, the term is applicable to all objects thrown forward for any purpose whatsoever, by a quick impulse. Specifically, it refers to the missiles thrown from the larger forms of ordnance; the term bullet being more applicable to those fired from the various forms of small-arms such as muskets, magazine rifles and pistols, revolvers, etc. (See Small-arms.) The earliest projectiles used as weapons in warfare were the arrows, darts, and stones, discharged by the various forms of mediæval ordnance such as the ballista and the catapult. (See Ordnance.) In the 14th century, when gun-powder cannon came into use, the arrows and darts were entirely superseded by stones, which continued in use, to a greater or lesser extent, during several succeeding centuries, although cast-iron projectiles were introduced for general use in the various European countries about the middle of the 15th century. The better shape of the iron projectiles increased the accuracy of gun-fire, while the reduction of the «windage» also added considerably to their velocity. (See Ordnance.) Although many attempts were made to perfect a breech-loading type of cannon, which would have allowed the use of still closer-fitting projectiles, they were practically unsuccessful. Similar conditions attended the attempts to perfect rifled guns, so that the use of smooth-bored guns and spherical projectiles prevailed up to the middle of the 19th century.



Combination Time and Percussion Fuse — (a) Shearing wire. (b) Hammer. (c) Steel needle. (d) Detonating cap. (e) Shearing wire. (f) Brass ball. (g) Centrifugal bolt. (h) Powder composition. (i) Copper detonator. (k) Powder.



Shrapnel.

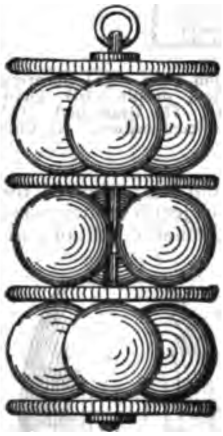


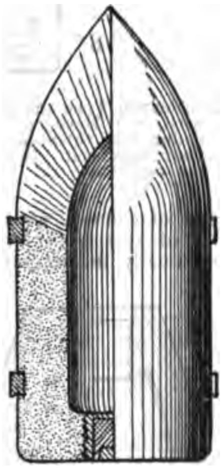
Muzzle-loading Shell (Studded Shell).

All smooth-bored ordnance were muzzle-loaders. They fired solid round-shot, case, common shell, and shrapnel shell.

Solid round-shot were made of cast iron and were used against the masonry of fortifications, wooden shipping, and massed troops. In naval battles they were often fired red-hot, being heated in special ovens before insertion in the gun.

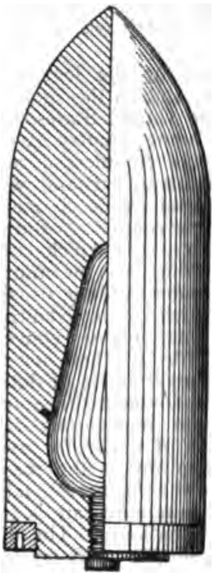
Case-shot consisted of a number of small iron or lead balls packed in metallic cylinders. At first, they were used in a form called «grape,» and consisted of a number of balls arranged around a central rod with a disk fastened at each end which together with a series of rings around the several layers of balls, held them in place. The whole was covered by a canvas bag. When fired, the balls were broken loose in the bore of the gun by the shock of discharge, but were held together in the bag for some little distance before final dispersion. Grape was superseded by «canister,» invented by Gen. Gribeauval of the French army, in which the thin metallic can containing the balls broke up after leaving the barrel, thus imparting to the smaller shot, at the moment of dispersion, the velocity of the projectile as a unit.

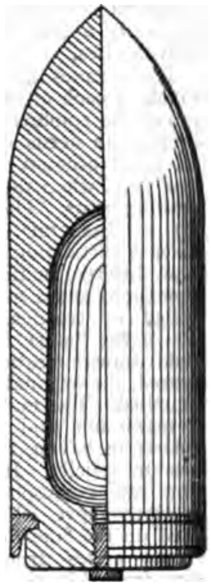

Grape-shot.


Palliser Shell
(chilled iron head).

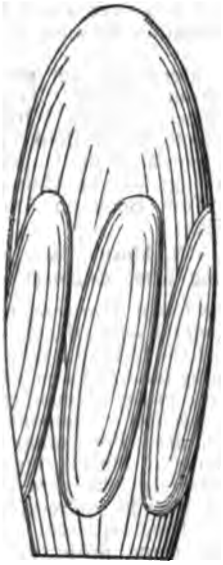
Common shell were first made of two hollow hemispheres fastened together and the interior completely filled with gun-powder. They were burst in flight by time fuses. At first, the fuse had to be lighted before inserting the shell in the gun, and resulted in many dangerous premature explosions, but in 1747, the French discovered that, if the earth tamping around the shell were omitted, the fuse would be ignited by the discharge. This not only removed the great danger of shell-fire, but expedited loading, and increased its use.

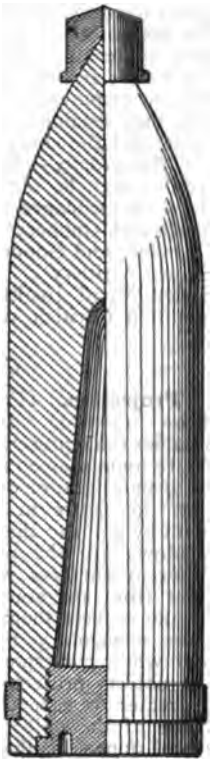
Shrapnel, perfected by Gen. Shrapnel of the British army, were designed for smooth-bored ordnance, but their use has been extended to rifled guns. They were used by the British with great effect during the Peninsular war, especially at the capture of Saint Sebastian, 31 Aug. 1813, when the ramparts were cleared by shrapnel-fire over the heads of the British storming party. They are one of the most important classes of shell, and when handled by skilful artillerists, are capable of producing very destructive results. A shrapnel shell consists of a hollow steel cylinder with walls somewhat thinner than that of the ordinary shell. It is filled with a number of lead or iron balls, and a small powder charge placed either in the front or rear end, just powerful enough to burst the cylinder and disperse the balls. They are burst by time fuses, or by percussion fuses. In the former, the shock of discharge causes a small plunger to shear a retaining pin and explode a cap which ignites a time train at such a point that it will explode the bursting charge after a predetermined number of seconds. Usually, the calculated time allows the shell to get within 100 yards of the object, when the balls are released by the bursting charge and continue onward in the form of a shower with the velocity of the projectile before bursting. In the percussion fuse, the shock of discharge causes a small plunger to break loose from its retaining wire. When the shell strikes, the plunger is thrown forward against a cap which it explodes, and thus ignites the bursting charge in the shell. Until the earlier part of the 19th century, explosive shell had been fired from mortars and howitzers only, but in 1821, Gen. Paixhans of the French army strongly advocated their use in long guns. His shell guns, the «Paixhans,» were adopted in the French navy about 1824, and led to the creation of armor-clad ships which in turn compelled the development of the rifled gun. (See ORDNANCE.) At first, the difficulty of constructing gas-tight breech-mechanisms caused the development of muzzle-loading rifles, but this erroneous system of construction did not last longer than a period of 25 years at the most, and the breech-loading rifle established itself firmly about 1875–80.

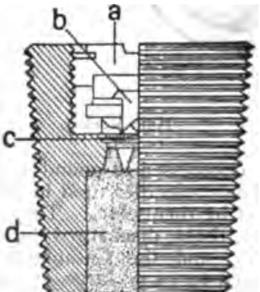

Muzzle-loading Shell
(Butler Shell).


Muzzle-loading Shell
(Parrott Shell).

Rifling.— Rifling was applied to guns to increase the accuracy of aim, and to give greater powers of penetration to the projectiles by increasing their velocity without lessening their weight. In the muzzle-loading smooth-bores the «windage» not only impaired the accuracy, but, by allowing the powder gas to rush past the projectile, reduced the velocity of its delivery; while an increase in the weight of the projectile could have been obtained only by an increase of calibre with a consequent loss of power. (See ORDNANCE.) In the muzzle-loading rifle, the rotation imparted to the projectile completely eliminated the inaccuracy of aim due to windage, and by allowing the use of elongated projectiles, enabled an increase in their weight without an increase of calibre, so that the longer and relatively narrower powder chambers concentrated the gas pressure and gave greater velocities. Muzzle-loading projectiles, however, had to be pushed into the gun from the front and were necessarily smaller than the bore, consequently, they still allowed an escape of gas and prevented the maximum effect of pressure. The earlier forms were provided with ribs or studs which fitted into the rifling grooves, but as the guns increased in size, the great strain of imparting rotation at the instant of starting forced out the studs and wore away the driving edges of the grooves. These difficulties were overcome by substituting the system of «increasing twist» rifling for that of the «uniform twist,» but did not obviate the shortcomings due to windage. The use of a flanged copper disk attached to the base of the projectile, which expanded under the pressure of the gas and cut off the windage completely, finally led to the removal of the studs and ribs altogether. About this time the construction of breech-loading rifles had reached such a stage of progress that considerations relative to projectiles were directed into an entirely different channel. In breech-loaders the projectiles are thrust into the gun from behind, therefore they could be used slightly larger than the bore, provided the excess was made of some softer metal that could be forced into the rifling grooves. At first these projectiles were coated with lead but proved quite unsatisfactory. Subsequently they were fitted with copper bands around the base, which, being slightly larger than the bore, were forced into the grooves as the projectile was pushed forward by the pressure, and not only took up the rotation imparted by the rifling, but also acted as an effectual gas check.

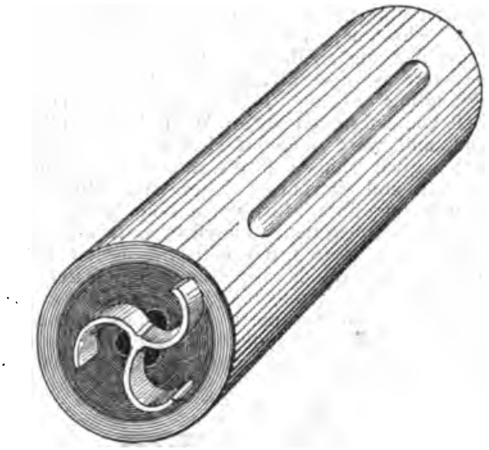

Muzzle-loading Shell (Ribbed Shell).


Modern Armor-piercing Shell (capped).



Direct Acting Percussion Fuse —(a) Safety fuse. (b) Steel needles and disk. (c) Detonating composition. (d) Powder. (e) Bottom plug.

Modern Projectiles.— The projectiles used in modern guns are common shell, armor-piercing shell, shrapnel, and canister. Excepting the armor-piercing shell, all of them are practically the same as those already described under corresponding names. The first armor-piercing shell were designed by Sir W. Palliser, of England, and were made of chilled iron, or steel, with ogival shaped heads, a form combining strength and sharpness. They were filled with powder introduced through a hole in the base, which was subsequently closed by a strong screw-plug. They were fitted with percussion fuses, arranged to explode them the instant after impact. Modern armor-piercing projectiles are used capped or uncapped. The latest forms of common shell are made with hardened points, and are designed to carry bursting charges equal to five per cent of their own weight, and penetrate armor at least one half of a calibre in thickness; they are used without caps. Armor-piercing shell are made of chrome steel, forged and tempered, and are designed to penetrate any thickness of iron or steel armor, through which they may be driven, without being broken to fragments or deformed by the impact. They are fitted with percussion fuses which are actuated by the impact and explode the shell after penetration. Those exceeding six inches in calibre are not loaded, as their walls are too strong to be burst by charges of ordinary gunpowder. Various kinds of high explosives, such as gun-cotton, nitro-glycerine, and certain picric acid compounds, much stronger than any from of gun-powder, have been used as bursting charges with more or less success, but the ever present danger from premature explosions due to the shock of discharge, has probably prevented the general adoption of any of them. (See EXPLOSIVES.) The thickness of homogeneous iron or steel armor they were capable of penetrating was limited only to their striking velocity, but against face-hardened armor they broke into fragments, or were flattened out and welded to the plates. It was discovered that the old compound armor could be easily pierced by them from the soft side. This led to the experiment of fitting soft-steel caps over their points, which were found to add greatly to their powers of penetration. Armor-piercing shell are generally about three and a half calibres in length, and weigh about one half of the cube of the calibre (expressed in pounds). (See NAVAL GUNS.) The projectiles used in pneumatic guns form a class by themselves. They are best represented by those discharged by the Zalinski, Sims-Dudley, and the Gathmann guns. They were designed to carry large quantities of gun-cotton, nitro-glycerine, or other high explosives. Each Gathmann shell contained at least one quarter of a ton of wet gun-cotton, and under test showed great destructive powers at a range of 5,000 yards. (See ORDNANCE.) Rockets form still another class of projectiles and are of three kinds — war rockets, signal rockets, and life-saving rockets. A rocket consists of a pasteboard or a metallic cylinder containing an inflammable composition which, when ignited, generates a quantity of gas of sufficient power to propel it forward. War rockets appear to have been first used in Oriental countries, and probably were invented by the Chinese. They were introduced in the British service by Sir W. Congreve, about 1827, who made them of iron cylinders, and used them for incendiary purposes. Congreve rockets were kept point-first, as they were driven through the air, by sticks fastened to their bases parallel to the axis of the cylinder, and worked on the principle of the feathers of an arrow. They were superseded by the Hale rocket which is kept point-first by the axial rotation imparted to the cylinder by a three-curved shield attached to its base, and actuated by the pressure of the gas escaping from the vents. Signal or sky rockets are small pasteboard cylinders with cone-shaped heads, filled with the composition which generates the propelling gas; a small bursting-charge of powder; and a quantity of other ingredients which, when the rocket bursts at its highest point of elevation, ignite into colored stars of great brilliancy, and visible at a great distance. Life-saving rockets are employed to carry a line over a wreck and thus establish communication between the vessel and the shore.



Hale Rocket.

Bibliography.— Special information on projectiles may be obtained from: Cooke, 'Text Book on Ordnance and Gunnery'; Bruff, 'Ordnance and Gunnery'; Ingersoll, 'Text Book on Ordnance and Gunnery'; 'Journal of the United States Artillery'; 'Proceedings of the United States Naval Institute'; 'Text Book on Ammunition (British War Office).'

W. MOREY, JR.,
Consulting Civil Engineer.

Projection. (From the Latin *projicere,* to throw forward). In its general sense, the term signifies the representation of the form of a given figure upon a given surface by means of a pencil of visual, light, or other rays, in such a manner, that the figure in the projection corresponds point by point to the given figure. For example, shadows are the projections of objects upon different surfaces which intercept the rays of light from any source, not already intercepted by the objects themselves. They represent the most elementary forms of plane projections, and while corresponding in general outline to the objects projected, yet differ from them to a greater or lesser extent according to the distance of the object from the source of light, the distance of the plane of projection from the object, the angle between the plane of projection and the direction of the rays of light, the position of the observer's eye, etc.

In the mathematical construction of projections, however, instead of a single plane being used to intercept the projecting rays, another surface, such as one formed by two planes at right angles to each other, is taken and the various points of any object, plane, or in space of three dimensions, projected to that surface from any point assumed as the center of the projection.

When the projection shows three dimensions of the object projected, it is commonly known as perspective, the mathematical theory of which together with the various classes of such projections employed in mechanics and for solving the problems of applied mathematics, will be found under the title Perspective, in this Encyclopaedia. The present article is confined to the consideration of the various projections used in connection with geographical and geodetical work in general, and to their employment in the construction of maps for special purposes.

In geographical and geodetical work, projections are solely used for representing the spherical surface of the earth on a plane. A suitable introduction to this particular phase of the subject is given under the title «Map» in this Encyclopaedia, wherein the three principal perspective projections of the sphere — the orthographic, the stereographic, and the gnomonic, are clerly explained and illustrated. Of these, the orthographic and the stereographic are rarely used at the present time except in the construction of what may be called pictorial maps; but, the gnomonic and several of its modifications are extensively used for the construction of star charts in general, and especially for charts showing the apparent tracks of shooting stars on account of the facility in determining the radiant point, the great circles on the celestial sphere appearing as straight lines on the projection. For similar reasons it is used in the construction of sailing charts showing steamship routes, and is much more satisfactory for this purpose than Mercator's projection, which although almost universally used for nautical charts, is specially applicable for those used by sailing ships.

The chief value of the perspective projections lie in their adaptability for representing large areas of the earths surface. Usually, they represent a hemisphere; but, by the employment of the «globular» or «equidistant» projection first proposed by Lahire in 1701, and subsequently modified by Lieut. Col. H. James of the Ordnance Survey of Great Britain and Ireland, fully two-thirds of the sphere can be shown within the bounding circle. This is accomplished by assuming the eye above the sphere at a distance equal to half the radius and perpendicular over the center of the plane of projection. The plane of projection is not that of a great circle, but is parallel to it and removed from it nearer to the eye by 23 degrees.

A simple and easily constructed perspective projection which can be effectively used in representing a hemisphere may be briefly described as follows: Draw a circle and bisect it by horizontal and vertical diameters; divide the circle into equal parts representing degrees of latitude; divide the vertical diameter into a corresponding number of equal parts; and divide the horizontal diameter into equal parts representing degrees of longitude. This will establish three points in every parellel of latitude, *i.e.* two in the circumference and one in the vertical diameter, through which the arc of a circle may be drawn representing the corresponding parallel of latitude, and also three points in every meridian, *i.e.* one at each pole and one in the horizontal diameter or equator, through which the arc of a circle may be drawn representing a meridian.

The general method of constructing developed projections by substituting cylindrical and conical surfaces for the ordinary plane of projection, and then rolling out those surfaces in a plane, has been briefly described under the title «Map» in this Encyclopaedia; but, as all modern maps representing data obtained from precise trignometrical surveys are based upon some form of developed projection, the mathematical theory and the practical methods of construction of such will receive more extended treatment herein.

The basic idea of developed projections results in two well defined types of the same — (1) those employing a cylinder tangent to the surface of the sphere, usually, at the equator, and (2) those employing a cone tangent, usually, at the middle parallel of latitude. It is obvious that various projections of either type may be obtained by varying the place of tangency relatively to the fundamental circles of the sphere, and also by substituting for the tangent cylinder, or cone, an intersecting cylinder or cone conforming to the condition, that the areas of the spherical zones projected shall bear the same proportion as the corresponding areas on the sphere.

The various projections that may be thus obtained form three definite groups — (1) those possessing straight meridians and parallels, (2) those of mixed systems of straight and curved meridians and parallels, and (3) those in which both meridians and parallels appear as curved lines.

Of the first group, the one most extensively used is Mercator's projection. It was devised to satisfy the following condition: That the loxodromic curve or the course of a ship on the surface of the sea, under a constant bearing or intersecting the successive meridians at the same angle, shall appear on the projection as a straight line having the same angle of bearing with respect to the meridians intersected as that of the loxodromic curve.

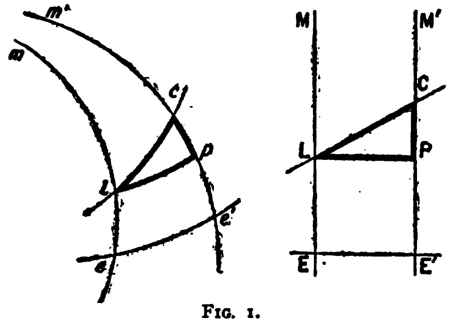


FIG. 1.

This condition is realized by assuming a cylinder tangent to the surface of the earth along the equator, with its axis coincident with the axis of the earth. The eye is assumed at the center of the sphere, and the various points upon the surface of the earth are projected by the visual rays upon the surface of the cylinder, so that, when the cylinder is divided along a meridian and unrolled upon a plane, the meridians appear as a system of equidistant straight lines parallel to each other and perpendicular to the horizontal line representing the equator, and the parallels of latitude appear as a system of straight lines parallel to the equator and intersecting the meridians at right angles, thus forming a system of rectangles the widths of which are variable, increasing from the the equator towards the poles in conformity with the law of progression required by the fundamental condition of the projection.

The formula used in computing a table of «meridional parts» or the «increased latitudes» for determining the distances of the various parallels of projected latitudes from the equator, is obtained as follows: (Modified extract from Projection Tables published by the U. S. Hydrographic Office).

Referring to Fig. 1, let *l c* be an element of the loxodromic curve between two consecutive meridians *m e*, m′ e′; and let L C represent the corresponding element on the projection between the corresponding meridians M E, M′ E′. Let *l p* and L P be taken parallel to the corresponding equatorial elements *e e′* and E E′ between the same meridians.

Then, the condition that the angles of bearing *l c p* and L C P shall be equal requires that

$$\frac{C\,P}{c\,p} = \frac{L\,P}{l\,p}$$

or since L P = E E′ = e e′ the element on the terrestrial equator, it is necessary that

$$\frac{C\,P}{c\,p} = \frac{e\,e}{l\,p}$$

Hence, putting *d s* for the meridional element *c p* of the terrestrial spheroid, *d m* for the meridional element C P of the projection, *a* for the equatorial radius of the earth, and *r* for the radius of the parallel represented by the element *l p;* then, on account of the proportionality of the elemental arcs *e e,′ l p,* to their respective radii *a, r,* we have the fundamental equation

$$\frac{d\,m}{d\,s} = \frac{a}{r}$$

which expresses the law of the Mercator projection.

Then, if L be the latitud of the terrestrial parallel under consideration, R the radius of curvature of the terrestrial meridian at its point of intersection with the parallel, *c* the compression of the earth, and *e* its meridional eccentricity; we have the following expression for the properties of *r*, R, and *e* of the terrestrial spheroid considered as an ellipsoid of revolution:

$$r = \frac{a - \cos\ L}{(1 - e^2\ \sin^2\ L)^{\frac{1}{2}}}$$

$$R = \frac{a\ (1 - e^2)}{(1 - e^2\ \sin^2\ L)^{\frac{3}{2}}}$$

$$e = \sqrt{2c - c^2}$$

Now, since the radius of curvature varies inversely as the angle between consecutive normals, the element of the terrestrial meridian at its intersection with any parallel of latitude is equal to the product of the radius of curvature and the element of latitude at that point, and

$$ds = R.\ dL,$$

which being substituted in the fundamental equation gives us the expression

$$dm = \frac{a\ R.\ dL}{r}$$

for the element of the projected meridian, or by substituting the preceding values of *r* and R, we have

$$dm = \frac{a\ (1 - e^2)\ dL}{(1 - e^2\ \sin^2\ L)\ \cos\ L},$$

which when integrated between the proper limits give the required length of any finite portion of the projected or chart meridian corresponding to the meridional arc on the terrestrial spheroid within the same limits.

For this integration, multiplying e^2 in the numerator by $\sin^2 L + \cos^2 L$, we have

$$dm = \frac{a.\,dL}{\cos L} - \frac{ae^2 \cos L.\,dL}{1 - e^2 \sin^2 L},$$

again, multiplying the numerator and denominator of the first term by cos L, substituting $1 - \sin^2 L$ for $\cos^2 L$, and resolving both terms into partial fractions, we have the expression

$$dm = \frac{a}{2}\left(\frac{\cos L}{1 + \sin L} + \frac{\cos L}{1 - \sin L}\right) dL - \frac{ae}{2} \left(\frac{e \cos L}{1 + e \sin L} + \frac{e \cos L}{1 - e \sin L}\right) dL,$$

whence, by performing the integration or the limits of O and L, we find for the length of that part of the meridian of the projection included between the equator and the parallel of latitude L, the expression

$$m = \frac{a}{M}\left(\frac{1}{2}\ \log\ \frac{1 + \sin L}{1 - \sin L} - \frac{1}{2}\ e \log \frac{1 + e \sin L}{1 - e \sin L}\right),$$

in which the logarithms belong to the common system, of which M is the modulus.

Substituting for

$$\frac{1 + \sin L}{1 - \sin L}$$

its trigonometrical equivalent, and for

$$\log \frac{1 + e \sin L}{1 - e \sin L}$$

its algebraic development, we have the final expression

$$m = \frac{a}{M}\ \log\ \tan\ \left(45^\circ + \frac{L}{2}\right) - a\,(e^2\ \sin\ L + \tfrac{1}{3}\ e^4\ \sin^3 L + \tfrac{1}{5}\ \ e^6 \sin^5 L.)$$

which is the formula required for computing the meriodional parts for the terrestrial spheroid.

This formula consists of two parts — the first term being the ordinary formula for computing meridional parts with the earth regarded as a sphere, while the second term consists of a series of negative terms, and represents the correction which must be applied for the meridional eccentricity of the earth under the hypothesis that it is an ellipsoid of revolution.

In using the formula to compute the accompanying table, the following numerical values with their respective logarithms have been employed for the several constants.

The equatorial radius is expressed in minutes of arc, therefore, the unit of measure of the meridional part *m* becomes a minute of the equator or a geographical mile.

$$a = \frac{10800'}{\pi} = 3437'.74677 \ldots\ldots \log\ 3.5362739$$

The reciprocal of the modulus of the common logarithms,

$$\frac{1}{M} = 2.3025851\ \ldots\ldots\ldots\ldots\ \log\ 0.3622157$$

Bessel's determination of the compression,

$$c = \frac{1}{100.1528} = 0.003342773 \ldots\ldots \log 7.5241069$$

The meridional eccentricity of the earth,

$$e = \sqrt{2c - c^2} = 0.0816968 \ldots\ldots \log 8.9122052$$

The values of the several coeficients with their logarithms deduced are as follows:

$$\frac{a}{M} = 7915'.7055 \ldots\ldots\ldots\ldots \log 3.8984896$$
$$ae^2 = 22'.9448 \ldots\ldots\ldots\ldots \log 1.3606843$$
$$\tfrac{1}{3} ae^4 = 0'.05104731 \ldots\ldots\ldots \log 8.7079734$$
$$\tfrac{1}{5} ae^6 = 0'.000204425 \ldots\ldots\ldots \log 6.3105351$$

On account of the rapid convergence of the series of coeficients involving the eccentricity, two terms are generally sufficient for practical use, and the formula becomes

$$m = 7915'7055 \log \tan \left(45^\circ + \frac{L}{2}\right) - 22'.9448 \sin L + 0'.05104731 \sin^3 L.$$

TABLE OF MERIDIONAL PARTS OR INCREASED LATITUDES FOR THE TERRESTRIAL SPHEROID — COMPRESSION $\frac{1}{299.1528}$.

LATS.	INCREASED LATS. (M)	LATS.	INCREASED LATS. (M)	LATS.	INCREASED LATS. (M)
°	′	°	′	°	′
1	59.60	31	1,946.10	61	4,629.12
2	119.22	32	2,016.20	62	4,754.69
3	178.88	33	2,087.02	63	4,884.46
4	238.59	34	2,158.64	64	5,018.76
5	298.38	35	2,231.12	65	5,157.98
6	358.26	36	2,304.49	66	5,302.51
7	418.25	37	2,378.81	67	5,452.84
8	478.37	38	2,454.12	68	5,609.50
9	538.64	39	2,530.48	69	5,773.10
10	599.09	40	2,607.93	70	5,944.31
11	659.71	41	2,685.53	71	6,123.96
12	720.55	42	2,766.34	72	6,312.97
13	738.62	43	2,847.42	73	6,512.44
14	842.93	44	2,929.86	74	6,72[illegible].64
15	904.52	45	3,013.70	75	6,948.13
16	966.40	46	3,099.02	76	7,187.76
17	1,028.59	47	3,185.91	77	7,444.80
18	1,091.12	48	3,274.46	78	7,728.07
19	1,154.01	49	3,364.74	79	8,023.14
20	1,217.29	50	3,456.87	80	8,352.55
21	1,280.97	51	3,550.95	81	8,716.35
22	1,345.09	52	3,647.09	82	9,122.69
23	1,409.66	53	3,745.41	83	9,582.99
24	1,474.72	54	3,846.05	84	10,114.02
25	1,540.29	55	3,949.14	85	10,741.71
26	1,606.41	56	4,054.85	86	11,509.61
27	1,673.10	57	4,163.35	87	12,499.22
28	1,740.38	58	4,274.81	88	13,8[illegible]3.54
29	1,808.31	59	4,389.44	89	16,267.70
30	1,876.90	60	4,507.46	90	Infinity.

On account of the space limitations, the table gives the meridional parts for even degrees of latitude only; the values for intermediate minutes or seconds of arc may be computed by the formula.

If the chart for which the projection is made includes the equator, the values given may be measured off for the successive degrees of latitude directly from the equator; but, if the equator is not included in the map, the parallels of latitude to be projected should be successively measured from a principal parallel, preferably the lowest parallel drawn upon the map, and the distance of any parallel from the principal parallel will be the difference of the values given for the two in the table.

These values, given in minutes of arc, may be converted into their equivalents in inches, yards, meters, etc., and laid off on the projection by means of properly divided corresponding scales, proportionately to the scale adopted for the map, or the values given may be laid off without previous numerical conversion, by means of a diagonal scale constructed on the map.

For example — suppose a Mercator projection is required to embrace the coasts of Iceland, on a scale of 1-inch = 150 statute miles. This island lies between latitudes 63° and 67° north, and between longitudes 13° and 25° west from Greenwich. The projection will include four degrees of latitude, and twelve degrees of longitude. The central meridian will correspond to longitude 19° W., and the lowest parallel will correspond to latitude 65° N. See Fig. 2.

Draw in the centre of the sheet a vertical straight line A B, for the central meridian, and near the bottom of the map construct very carefully a horizontal line C D, at right angles to A B, for the parallel of 63° N., and assume it as the principal parallel of the map. From the table obtain the value 4884′.46 for lat. 63°, and 5452′.84 for lat. 67°, the difference of which or 5452′.84 — 4884′.46 = 568′.38, the value of the meridional arc included between the lowest and the highest parallels of latitude of the map, for which one minute of arc of the equator = 1.012 statute miles is taken as the unit of measurement. Converting this value to its equivalent in statute miles and reducing it to the scale of the map, gives 568′.38 ÷ 60′ = 9°.47; 9°.47 × 69.77 statute miles (equivalent to a degree of longitude on the equator) = 660.72 statute miles; 660.72 ÷ 150 = 4.40 inches or the distance of the parallel of 67° from the parallel of 63° on the map, on a scale of 1-inch = 150 statute miles. It is obvious that this measurement may be laid off on the map by means of any scale divided to the decimals of an inch, and the distance of each of the other parallels from the principal may be obtained by the same method of conversion and laid off in a similar manner; but, having obtained the value 4.40 inches equal to the vertical extent of the map, we are enabled to determine a constant multiplier by the use of which the tabular values may be laid off directly by means of a diagonal scale of one inch without previous numerical conversion. As 1′ of arc of the equator is taken as the unit of the meridional arc, 1′ of arc of latitude will measure 4.40 inches ÷ 568′.38 = 0.0077 inches, which corresponds to the scale of the map and by which all the values obtained from the table must be multiplied if they are to be laid off on the projection by means of a diagonal scale of one inch.

The distances of the successive parallels from the parallel of 63° thus obtained are as follows:

0.0077 × (5018.76 — 4884.46) = 1.03 in. (64°)
0.0677 × (5157.98 — 4884.46) = 2.11 in. (65°)
0.0077 × (5302.51 — 4884.46) = 3.22 in. (66°)
0.0077 × (5452.84 — 4884.46) ÷ 4.40 in. (67°)

These distances may now be laid off upon the central meridian from its intersection with the principal parallel in the order 1, 2, 3, 4, shown on Fig. 2, and through the points thus obtained straight lines may be drawn parallel to the principal parallel, and corresponding to the terrestrial latitudes of 64°, 65°, 66°, and 67°.

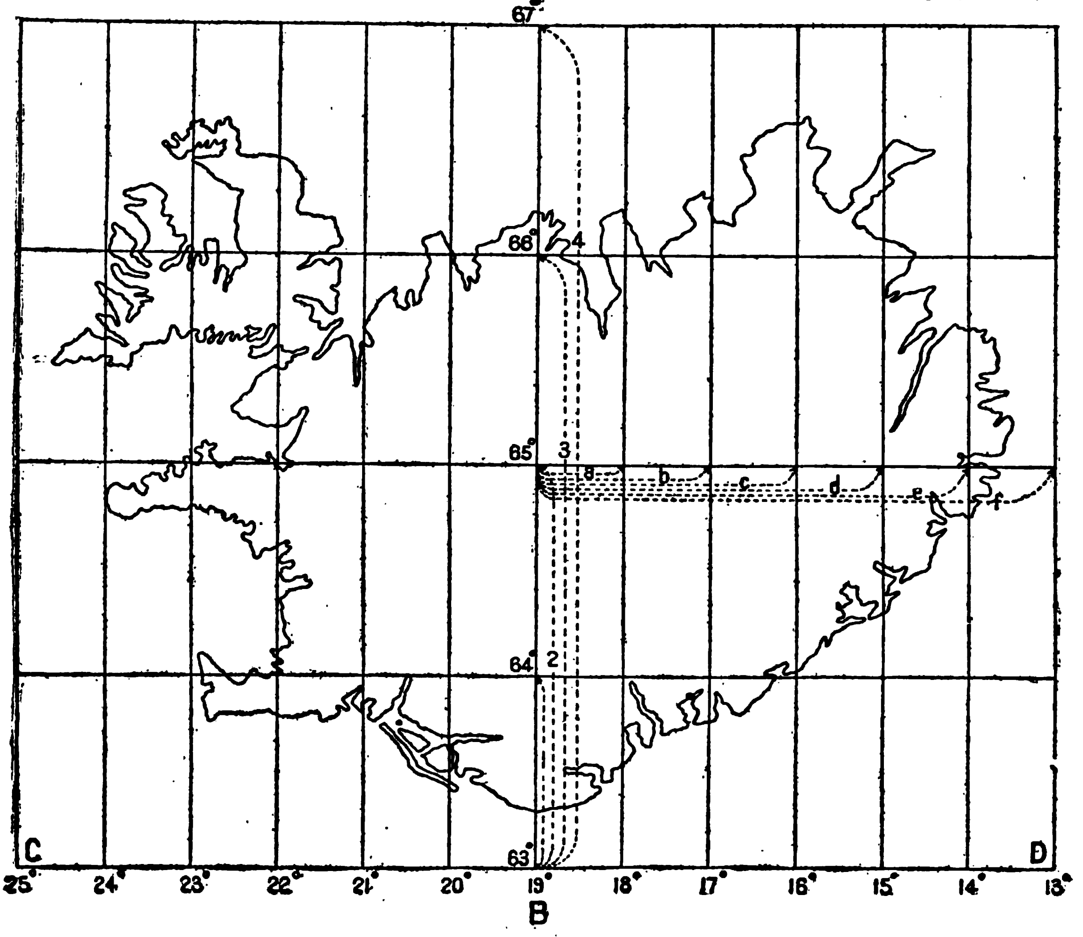


Fig. 2.

On this map, a degree of longitude will measure 0.0077 inches × 60 = 0.46 inches, and the distances of the successive full degrees of longitude east and west of the central meridian will be 0.46, 0.92, 1.39, 1.83, 2.31, 2.77 inches. Lay off these values on the lowest, middle, and highest parallels of latitude, east and west from the central meridian, in the order a, b, c, d, e, f, and through the points thus obtained draw straight lines parallel to the central meridian, and corresponding to the terrestrial longitudes of 13° 14°, 15°, 16°, 17°, 18°, 19°, 20°, 21°, 22°, 23°, 24°, and 25°, west from Greenwich.

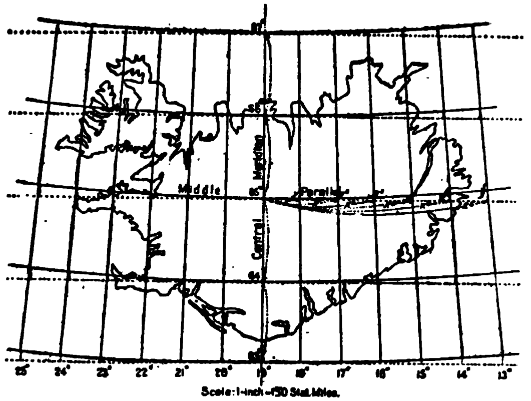


Fig. 4.

The second group of projections, those having mixed systems of straight and curved meridians and parallels, includes various kinds of "equal surface" and "conic" projections, of which the "simple conic" is the most valuable for general purposes. In this projection it is assumed that a cone, the apex of which lies in the axis (produced) of the sphere, is tangent to the surface of the sphere along a parallel of latitude. When the surface of the cone is developed on a plane, the parallel of tangency becomes an arc of a circle, having for its radius the slant side of the cone which is equal to the cotangent of the latitude. A part of this developed arc of a circle, of sufficient length to include the desired number of degrees of the proposed map, is drawn through the middle point of the central meridian and forms the middle parallel of the map. The central meridian north and south of this line is divided into degrees of latitude laid off according to scale proportional to their true lengths on the sphere, and parallels of latitude concentric to the middle parallel are drawn through the several points thus obtained. In a similar manner, the middle parallel is divided into degrees of longitude east and west of the central meridian and straight lines representing meridians are drawn through those points to the centre from which the concentric parallels were swept. In the system of co-ordinates thus established, the parallels and meridians intersect each other at right angles, precisely the same as on the sphere, and corresponding infinitely small parts on the sphere and projection are similar in figure. The lengths of the degrees on the central meridian and on the middle parallel are proportionately the same as those on the sphere, and the lengths of the degrees on all the other meridians and parallels are but slightly different from what they would be if laid off their true length proportional to those of the sphere.

The foregoing brief description of the "simple conic" projection serves to illustrate the employment of tangent cones in the construction of developed projections, and leads the way to the consideration of the theory of those of the third group, in which both meridians and parallels are curved lines; approaching much closer to the actual positions on the earth's surface, and therefore more suitable for use in the construction of accurate maps.

Of this class, one of the most useful and extensively used is that devised by Bonne. It is sometimes called Flamsteed's modified projection, but the latter is really a particular case of the former. Bonne's projection differs from the "simple conic" in that each of the concentric parallels of latitude is divided into degrees of longitude, the lengths of which are proportional to their true lengths on the sphere, and curved meridians are drawn through each corresponding series of points. The central meridian remains a straight line, and the curvature of the arcs of the successive parallels is the same as that of the middle parallel, the radius of which is equal to the cotangent of the corresponding latitude. Thus, all the meridians intersect a parallel near the middle parallel at right angles, and the outlines of areas on the projection are very nearly similar to those on the sphere. It not only preserves the proportionate equality of the areas on the sphere and projection, but permits of the use of the same linear scale for all parts of maps of only a few degrees in extent. This projection was adopted as the base for the important map of France constructed by the Depôt de la Guerre in 1803.

The step from the simple conic to the Bonne was an important one; but, the great obliquity of the meridians and parallels in the higher latitudes, made it unsuitable for maps of large extent and led to the invention of the "polyconic" projection, which appears to have been conceived by F. R. Hasler, superintendent of the United States Coast and Geodetic Survey, between 1816 and 1820. It was proposed by him as the most suitable base for the maps of the Atlantic coast of the United States, the great length of which, north and south, together with its direction nearly diagonal to the meridians and parallels, made it subject to inadmissible deviations in magnitude and figure upon a Bonne projection.

In the polyconic projection, it is assumed that each parallel of latitude is developed upon its own cone, the vertex of which is on the axis of the sphere at its intersection with the tangent to the meridian at the parallel. Theoretically, this involves the employment of an infinite number of tangent cones, and the independent development of an infinite number of parallels of latitude. This has the effect of increasing the lengths of the successive degrees of latitudes and longitudes as their distances from the central meridian increases; but, the angles at which the meridians intersect the parallels, over the entire map, very closely approximate to right angles, thus preserving a close similarity between the figure on the projection and the corresponding figures on the sphere.

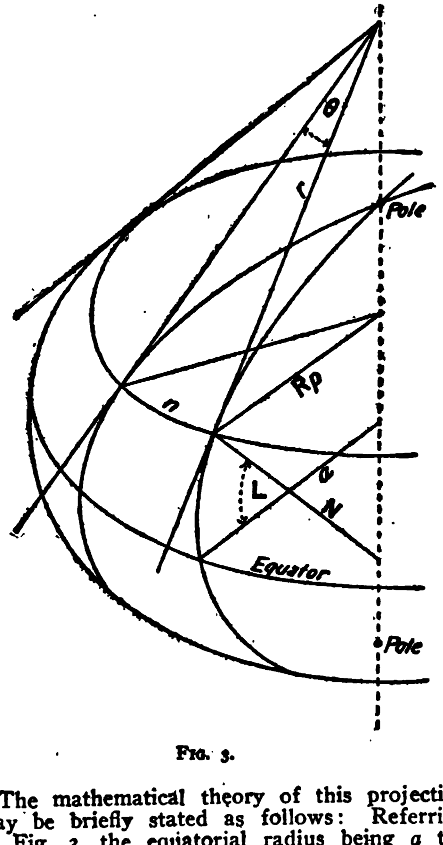


FIG. 3.

The mathematical theory of this projection may be briefly stated as follows: Referring to Fig. 3, the equatorial radius being a the eccentricity e, and the latitude L, the normal produced to the minor axis is

$$N = \frac{a}{(1 - e^2 \sin^2 L)^{\frac{1}{2}}},$$

the radius of the parallel

$$Rp = N \cos L;$$

and the sides of the tangent cone or radius of the developed parallel

$$r = \text{N} \cot \text{L}.$$

If n be any arc of the parallel to be developed, and θ the angle which subtends it at the vertex when developed

$$\theta = n \sin \text{L};$$

and as the developed parallels are circular arcs, the co-ordinates of curvature are

$$x = r \sin \theta,$$
$$y = r \operatorname{versin} \theta = 2r \sin^2 \tfrac{1}{2}\, \theta = x \tan \tfrac{1}{2} \theta.$$

The radius of curvature in the meridian is

$$\text{R}m = \frac{a\ (l - e^2)}{(l - e^2 \sin^2 \text{L})^{\frac{3}{2}}} = \text{N}^3 \frac{l - e^2}{a_2};$$

whence the length of a degree of latitude is

$$3600\ \text{R}m \sin l'',$$

and that of a degree of longitude is

$$3600\ \text{R}p \sin l''.$$

For maps of large extent, on a small scale, it is sufficient to compute r and θ, x and y, for every whole degree, but for those of small extent, on a large scale, a more detailed projection becomes necessary and these values have to be computed to every minute or fractions of a minute according to the nature of the data to be represented, and the value of the scale adopted.

To make a projection from the data furnished by a polyconic projection table, draw a straight vertical line for the central meridian and, lay off thereon the distances corresponding to the intervals between the successive latitudes required, and through the points thus obtained draw horizontal lines at right angles to the central meridian. These horizontal lines will be tangent to the developed parallels.

Now suppose, that as in the case of the Mercator projection hereinbefore illustrated, the polyconic projection is required to embrace the coast of Iceland, which lies between lats. 63° and 67° north, and between longs. 13° and 25° west from Greenwich, and that the scale of the map is adopted as 1-inch = 150 statute miles.

Referring to Fig. 4, inserted under Fig. 2, the central meridian of the map will correspond to longitude 19° west, and the middle parallel will correspond to 65° north. On the central meridian lay off to the north from its intersection with the middle parallel, according to the adopted scale, 69.268 miles for latitude 66°, and 69.277 miles for latitude 67°, and in a similar manner lay off to the south, 69.258 miles for latitude 64°, and 69.248 miles for latitude 63°. Through these points draw horizontal lines at right angles to the central meridian, and upon each of them set off to the east and to the west of the central meridian the values of x given in the table for the corresponding parallels of latitude. Through the points x, x^1, x^2, etc., thus obtained, draw perpendiculars towards the pole, and on them set off the proper tabular values of y. Through the final points thus obtained, draw continuous curves for parallels of latitude and meridians.

Space limitations in this Encyclopedia make it absolutely impossible to insert a polyconic table computed to even full degrees only, and one giving the values of x and y for greater latitudinal and longitudinal intervals would be more or less useless. Tables of this kind may be readily obtained from the U. S. Coast and Geodetic Survey, and the U. S. Hydrographic Office, Navy Department.

Fig. 4 is placed under Fig. 2 in order to afford a direct comparison of the two projections.

Bibliography.— For further information consult the various authorities given under the title MAP in this Encyclopedia.

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Projective Geometry. See GEOMETRY, PURE PROJECTIVE.

Prolapsus Ani, falling of the anus. See RECTUM.

Prolapsus Uteri, falling of the womb. See WOMB.

Proletariate, prō-lē-tā'rĭ-āt, a general term applied to those Roman citizens who stood in the sixth class, possessing less than 1,500 asses, or nothing at all. They were ever afterward distinguished by the name of *capite censi*, apparently because they were taxed only by head. The term has been revived in modern times as a designation of the lowest class of the community who possess no capital; and is frequently used in socialistic literature.

Proloc'utor, in the Lower House of the English Convocation, a member chosen by the House, and presented to the bishops who form the Upper House as the person through whom all resolutions will be communicated to the Upper House. The prolocutor acts as chairman and moderator of the Lower House.

Prologue, in dramatic poetry, (1) in the Greek drama, that part of a tragedy preceding the first appearance of the chorus. (2) In the Roman and English drama, an address to the audience preceding the piece itself. It may be either in prose or verse, and is usually pronounced by one person. Among the Romans the player who delivered this address was called the *prologus*, and usually considered as a person of the drama. Thus in the 'Amphitryon' of Plautus (q.v.) Mercury appears as *prologus*. Prologues sometimes relate to the drama itself, and serve to explain to the audience some circumstances of the action, sometimes to the situation in which the author or actor stands to the public, and sometimes have no immediate connection with either of these persons or subjects. Shakespeare makes use of the prologue, as in 'Henry V.' and the Restoration drama almost invariably employed it. It long since fell into disuse, but is occasionally revived for the effect of quaintness.

Prome, prōm, India, (1) a town of Lower Burma, capital of a district of the same name, on the Irawadi, about 160 miles from Rangoon by rail. It is a large town surrounded by a wall, with extensive suburbs; owing to the flat ground on which it is built it is subject to inundations from the river. It has silk-weaving and other industries, and exports silk, rice, cotton, etc. Pop. about 30,000. (2) The district has an area of 2,914 square miles, and a pop. about 375,000.

Promessi Sposi, I, prō-mĕs'sē spō'zē ē, an Italian romance by Alessandro Manzoni, published in 1825, dealing with Milan under the Spanish rule of the 17th century. In fidelity to life, the interest of its principal characters, and the beauty and truth of its descriptions, it stands as the greatest Italian historical romance, and its author as the creator of a school of historical novelists.

Prometheus, prō-mē'thūs, in Greek mythology, son of Iapetus the Titan and Clymene, or Themis (according to Æschylus), or Asia (according to Apollodorus). He is the legendary giver of fire and all its benefits to men. Hesiod and Æschylus, the latter of whom made his story the subject of a trilogy of which one tragedy, ‘Prometheus Bound,’ is alone extant as a whole, are our chief authority for the myth concerning Prometheus. He is represented as the brother of Atlas, Menœtius, and Epimetheus. According to Æschylus, Prometheus took part with Zeus against his brother Titans and by his craft and sage counsel rendered Zeus victor, and enabled him to ascend his father's throne. Later, objecting to the plan of Zeus to destroy mankind and create a new generation of beings, he helps the weak race of mortals by stealing fire from the lightnings of Zeus and giving it in a hollow reed to men, to whom it had been till then denied. In revenge Zeus has Prometheus chained to a rock in the Caucasus by Hephæstus and his helpers Kratos and Bia, and sends a vulture to tear forever at his vitals, not allowing him to end his pain by death. Steadfastly Prometheus bears his doom, aware that in time Zeus will fall by the hand of a son born to himself and Thetis. Heracles, with the consent of Zeus, slays the vulture and releases Prometheus, who returns to Olympus and thereafter is the wise counsellor of the gods. It is in the above form that the myth has been most generally accepted, but it was varied in many ways by different poets and philosophic interpreters. His Greek name, meaning "Forethought" (that of his brother Epimetheus, signifying "Afterthought"), makes the underlying allegory apparent. Prometheus, as the friend of men, the wise helper in necessity, and in some interpretations as a rebel against unjust authority, has been much referred to in literature, and in modern times was made the subject of Shelley's ‘Prometheus Unbound,’ and of the fragment of a tragedy by Goethe. He has also been frequently represented in plastic art. Consult: Weiske, ‘Prometheus und sein Mythenkreis’ (1842); Holle, ‘Die Prometheussage’ (1879).

Promise, an engagement entered into by one person to perform or not perform some particular thing. When there is a mutual promise between two parties it is termed a contract. A promise may either be verbal or written. See CONTRACT.

Promise, Breach of. See BREACH.

Promissory Note, is an unconditional promise in writing for the payment of money in a sum certain, absolutely, and at all events; it is negotiable when it is transferable from one person to another by endorsement or delivery, so as to vest in the party taking it the legal title to the note and to the property it represents: they are of ancient origin and were in use by the Romans. Under the law, generally, notes are assignable, so that the assignee may bring an action thereon in his own name. The usual parties to a promissory note are the drawer, the payee to whom it is drawn and the endorser. The important characteristic of a negotiable note is that the person receiving it does so for value and without notice of any question of title of the previous holder. Anything on the face of a note sufficient to put a transferee upon inquiry, subjects him to any defenses between all the original parties; one taking negotiable paper that is overdue, does so under like conditions. Possession of a negotiable note which is payable to drawer, or which is endorsed in blank, or to the holder specially, is presumed to be legal in every respect. A note to which any signature is attached, through which the holder claims, that has been forged, is not good. The holder of a note can bring an action thereon, except that it is payable to another, especially a note endorsed in blank. If a note is made subject to any conditions as to demand or notice, same must be first complied with before action can be brought. Protesting of a note is the declaration by the holder against any loss on account of non-payment; its object is to give notice to the endorsers of their consequent liability; such notice is essential, and it is customary that protest be made by a notary public. Many important subjects in relation to the laws governing promissory notes are the subject of statutes, which differ in various jurisdictions. See also INDORSEMENT; NEGOTIABLE PAPER; NOTE.

Prong'buck, the American pronghorned goat-antelope (*Antilocapra americana*), one of the two sole living representatives on the American continent of the large series of Old World antelopes (*Bovidæ*), the other being the Rocky Mountain goat (*Oreamnos montanus*), which is more nearly a true antelope than a goat. Although almost universally known as "antelope," the pronghorn differs so greatly from the true antelopes that it is made the type of a distinct family (*Antilocapridæ*), having affinities alike with the giraffes, deer, and goats. The horns, while resembling those of the true antelopes and the *Bovidæ* generally in consisting of a bone-core covered by a horny sheath, differ from those of all *Bovidæ* in the presence of a short anterior spur or branch. Furthermore they are more or less densely and extensively covered with hair, thus resembling the horns of the giraffe. But by far the most remarkable peculiarity of these horns is that they are shed annually like a deer's antlers. So skeptical were zoologists as to the possibility of a hollow-horned ruminant shedding its horns, that, although the fact was known to hunters for many years, and had been repeatedly reported, it was not until 1865 to 1868 that the truth of these reports became fully established. The entire horn is not shed as in the case of deer, but only the horny sheath, the bony core remaining intact and permanent, and its epidermal covering immediately beginning to regenerate a new horn.

The pronghorn is about three feet high and five feet long, with a very short tail, slender legs, pointed, erect ears, and extremely large eyes. Two important characteristics are the absence of the small accessory hoofs from both fore and hind feet, and the hairiness of the end of the muzzle except along a narrow median line. The color is a variable and somewhat mottled brown, with a chestnut colored mane and a brilliant white rump patch or so-called recognition mark. Both sexes have horns; but those of the female and young are smaller and simple. Since the disappearance of the bison, the prongbuck is the most characteristic ruminant animal of the great western plains. Although the progress of settlement has much diminished its numbers and reduced the limits of its range both easterly and westerly, the prongbuck still holds its own over an area extending for about 30 degrees from Saskatchewan on the north to the Mexican state of Zacatecas on the south, and from the Dakotas and Kansas westward through the Rocky Mountains and in the Cascades into Oregon. It occurs in Arizona and at a few points in California, but is absent from large areas in Colorado, Utah, New Mexico, and Arizona. Prongbucks live in bands on the open plains or in the hilly countries; bucks, does, and fawns associating during the greater part of the year, but at the close of the gestation period, which varies from March to September, according to latitude, the pregnant does separate to drop their two fawns in solitude, and the old bucks wander into the wooded hills. Their natural food consists almost entirely of grass, though grain, apples, etc., will be eaten in captivity. They are wonderfully alert animals, with keen senses, and so timid that they retreat on the slightest alarm, but withal so curious that they soon pause to gaze at the cause of their alarm. Their speed is marvelous, and their bounds of tremendous extent, but their power of endurance is not great and they never leap over an obstacle of any height. They may be domesticated with comparative ease and sometimes breed in captivity; and it is said that a fence of only three or four feet high is quite sufficient to confine them. Owing to the excellence of their flesh, though it is rather dry, and their splendid game qualities, they are much sought by hunters. The methods most in vogue are coursing with grey or deer hounds, running with relays of horses, and stalking, the latter especially requiring much skill, though they may be lured toward the concealed hunter by an appeal, by means of a fluttering colored cloth or handkerchief, to their inordinate curiosity. The Indians hunted them by stalking, sometimes dressed in the skin of one of their kind; by driving them into brush enclosures, over which they would not leap; and in other ways. Consult: Caton, ‹Antelope and Deer of America› (Boston 1881); Roosevelt, ‹American Big Game Hunting› (New York 1901) and ‹The Deer Family› (New York 1902).

Pro'noun, a part of speech which takes the place of the noun, to avoid too frequent repetition of the noun. It differs from the noun in this, that whereas the noun stands always for some definite object or concept or class of concepts, for example, Chicago, man, house, the pronoun may stand now for a given concept or class of concepts; but again for a totally different one: thus the pronoun has no fixed denotation: «it» may stand for «Chicago,» or «horse,» or «universe.» A usual classification of pronouns divides them into those personal (I, thou, he, she, it, me, you, they), demonstrative (the, this, that), interrogative (who? which? what?), possessive (my, thy, his, her, hers, its, our, ours, your, yours, their, theirs, whose), relative (who, whom, which, that), and indefinite (any, aught, some, each, every, other, etc.): but the demonstratives and the indefinites do not, as a rule, fall under the definition of pronoun. Worthy of note is the general going out of use (at least in polite society when equals address equals) in all modern languages, of the personal pronoun (and its possessive) of the second person singular, thou, thy, thine, and the substitution for it of the second person plural, or (in German) the third person plural, or of a form signifying «your worship» or the like.

Pronun"ciamen'to, in Spanish-American republics a proclamation against the existing government, intended to serve as a signal of revolt. The word *contrepronunciamento,* that is, counterproclamation, also occurs.

Pronuncia'tion, the act of uttering words or articulate sounds of the voice. The alphabetic characters are designed to represent with more or less precision the voice-sounds of a language; and if all those sounds have each its proper sign, a written word will be a sure index of its pronunciation. The alphabet of the Spanish language is nearly perfect in this respect. In Spanish the vowels have each one quality of sound: in whatever situation, they have each but one value, and a, e, i, o, and u are pronounced respectively as a in father, ei in rein, ee in see, o in lone, and oo in moon. The consonants, too, have only one sound, except that before the vowels a, o and u, and before consonants, c has the sound of k, and g the hard sound of g in get; also, to represent special sounds, l is doubled (lleno, pron. l'yamo) or a diacritical mark is used (año, pron. ahnyo). Not so in English. In English each of the vowel and consonant signs designates various sounds. Thus the vowel sign a denotes at least six different vowel sounds; e at least four; i at least three; o (including oo) seven, and u in four; often they are silent, representing no sound. Many of the consonants, too, though not to the same extent as the vowels, represent each, whether singly or compounded, two or more different sounds; examples: cede, call, child, machine, chemic. Other consonants which stand for more than one sound are s (sat, has, sure), t (tan, thin, thine, nation), n (sin, sing); etc.

The different sounds represented by the vowel sign a are: (1) the short vowel sound which it oftenest represents: it is heard in man, cab; this sound is almost peculiar to English; it differs slightly from the short a of French, and considerably from the short a of German; Germans who are beginning to learn English have difficulty at first in producing this English vowel sound and instead of man say men, het instead of hat. (2) The long sound of a as in hate, late: its sound is that represented in other languages by the second vowel e; in German and other languages the sound of the word bane would be represented by ben or behn or bên, etc. (3) The sound of a (however represented — by a, or ei, or ea, etc.) — before r in the same syllable, as in share, bear. A vulgar mispronunciation of such words is shar, bar; in Irish pronunciation the a in share, bear, pear, etc., has precisely the same sound as in shape, lane, bane. (4) The sound of a in father, calm, far: this is usually styled the Italian sound of a. (5) The sound of a in ask, branch, pass, differing from the pronunciation of the same letter in at, tan, pan: it is the short sound of the a in father. In England and New England the distinction is made between the sound of a in branch, ask, etc., and the a in ban, ran; elsewhere in the United States it is not observed. (6) The sound of a in all, warm, talk, is peculiar to English; it is much broader than a in German words all, fall. (7) The sound of a in what, wander, is peculiar to English; it is represented by o in not, gone, etc. The sounds of e are (1) its short sound as in net, sent; (2) the long sound as in obese, mete, green: this sound is represented in most other languages by the third vowel i; (3) the sound which it has in vein, rein: in other languages this is the primary sound of this vowel; (4) the sound, peculiar to English, which it has before the letter r as in per, confer. Three sounds are represented by i; namely: (1) the short sound as in pin, bin; (2) the corresponding long sound as in marine: this is the regular sound of i in other languages; in English i is so sounded only in a few words; (3) the long sound heard in pine, ride: this is a diphthong and equal to ei or ai. The vowel o represents the following sounds: (1) Its primary sound in English and other languages, as in ode, lone; (2) a short sound peculiar to English, as in not, nod: this is not the o of ode shortened; the shortened o of ode is unknown in English; (3) the obscure short sound (same as that of u in but) heard in other, son, done; (4) the sound heard in prove, move: this is the long vowel u of German, Spanish, etc., and the ou of French; (5) the same sound shortened, as in wool, book, took; (6) a sound closely resembling that of a in all: it occurs when o is followed by r in the same syllable, as in order, corner; in Irish pronunciation this o has the same sound as a in all. The sounds represented by u are: (1) that heard in rule, rumor, Lucifer: here it is equal to oo in moon, and it represents the sound of u in German, Spanish, Italian, etc., but not in French; (2) the corresponding short sound heard in put, bull; (3) the peculiar sound given it before r in the same syllable, as in urge, urn; (4) the diphthongal sound that u has in union, pure: here u is equal to yu or eu. In the United States long u after l has always the sound of oo in ooze: but dictionaries which represent the pronunciation of such words as lurid, luce, in England, give to the u the same value it has in cure, that is, the diphthongal sound (l'yurid, l'yuce), though in the same dictionaries the u in luna, lunary, ludicrous, etc., is represented the same as in rule. In the United States the u in such words as duty, tulip, is commonly mispronounced as dooty, toolip, instead of d'yuty, t'yulip; the Irish mispronunciation of such words is jooty, tshoolip.

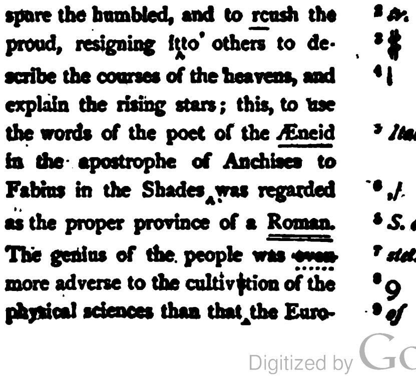
In the pronunciation of various consonants English is peculiar, or differs from other languages in sundry respects; for example, ch in English words is equal to tsh (chat), or to sh (chivalry) or to k (chemism). The d and t of English are pronounced with the tip of the tongue touching the gums well above the teeth; in other languages the contact is at the roots of the teeth. The th in thin is almost peculiar to English, but the same sound exists in Spanish; the sound of th in thy, that, is peculiar to English. In Irish pronunciation the sound of th in thank, thousand, is produced by firm contact of the end of the tongue with the teeth and forcible emission of the breath. In the Irish pronunciation of thy, that, there is also contact of the tongue with the teeth and gums.

Prony, prō-nē, **Gaspard Clair François Marie Riche,** BARON DE, French engineer: b. Chamelet, Rhone, 22 July 1755; d. Asnières, Seine, 28 July 1839. He received his technical education at the École des Ponts et Chaussées. As assistant to the civil engineer Perronet he was employed in building the bridge De la Concorde at Paris, and the restoration of the harbor of Dunkirk. Made head of the board of survey, in 1791 he superintended the construction of new trigonometrical tables, extended to 25 decimal places, necessitated by the establishment of the metric system. This great work in 17 volumes is preserved in manuscript at the Observatory at Paris. In 1794 he was appointed professor of mathematics at the polytechnic school, and in 1798 director of the École des Ponts et Chaussées. Under Napoleon he executed improvements in the harbor of Genoa, Ancona and Venice, and in the navigation of the Po. He wrote several works of a technical character connected with the engineering operations of which he had charge.

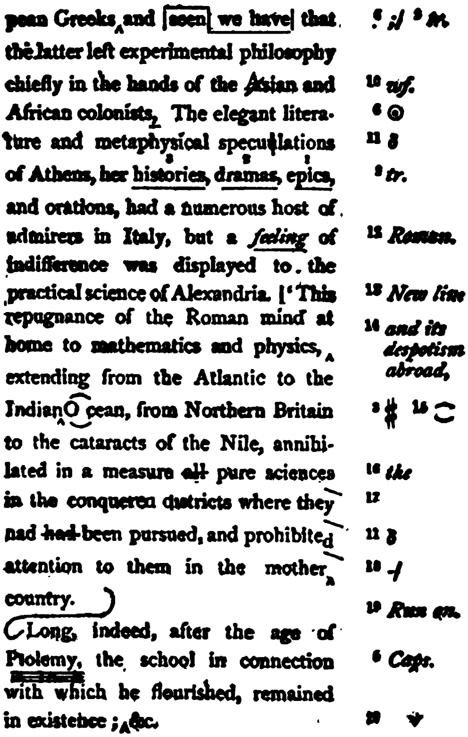
Proof (in law). See EVIDENCE.

Proof, Ontological, or **Ontological Proof,** See ONTOLOGY.

Proof-reading, in typography, the corrections to be made on a "proof" of printed matter are marked on the margin; and for this purpose an established set of signs is used. The following specimen of a proof exhibits the application of most of these signs:



'To rule the nations with imperial
swøy, to impose terms of peace, to — 1 a
spare the humbled, and to rcush the — 2 tr.
proud, resigning itto' others to de- — 3
scribe the courses of the heavens, and — 4
explain the rising stars; this, to use
the words of the poet of the Æneid — 5 Italic.
in the apostrophe of Anchises to
Fabius in the Shades was regarded — 6 ,/
as the proper province of a Roman. — 8 S. caps.
The genius of the people was even — 7 stet.
more adverse to the cultivation of the — 8 9
physical sciences than that the Euro- — 9 of



pean Greeks and seen we have that. 8 ;/ 2 tr.
the latter left experimental philosophy
chiefly in the hands of the Asian and 10 wf.
African colonists The elegant litera- 6 ⊙
ture and metaphysical specuулlations 11 ȣ
of Athens, her histories, dramas, epics, 5 tr.
and orations, had a numerous host of.
admirers in Italy, but a *feeling* of 12 Roman.
indifference was displayed to. the
practical science of Alexandria. ['This 13 New line
repugnance of the Roman mind at 14 and its despotism abroad,
home to mathematics and physics,
extending from the Atlantic to the
Indian O cean, from Northern Britain 3 # 15 ⁀
to the cataracts of the Nile, annihi-
lated in a measure ~~all~~ pure sciences 16 the
in the conqueren districts where they 17
had ~~had~~ been pursued, and prohibited 11 ȣ
attention to them in the mother 18 -/
country.
Long, indeed, after the age of 19 Run on.
Ptolemy, the school in connection 5 Caps.
with which he flourished, remained
in existence ; &c. 20 ✓

(1) A wrong letter. After every mark of correction a line | should be drawn, to prevent its being confounded with any other in the same line. (2) A word or letter to be transposed. Where letters only are to be transposed, it is better to strike them out, and write them in their proper sequence in the margin, like a correction. (3) A space wanted. This mark is also used when the spacing is insufficient. (4) A space or quadrant sticking up. (5) Alteration of type. One line is drawn under the word for *italics*, two for SMALL CAPITALS, three for CAPITALS. (6) Correction or insertion of stops. (7) A word struck out, and afterward approved of (Latin *stet*, "let it stand"). (8) A turned letter. (9) An omission. (10) A letter of a wrong font. (11) A word or letter to be deleted. (12) Alteration of type. (13) A new paragraph. (14) Insertion of a clause. (15) A space to be removed or diminished. (16) A wrong word. (17) When letters or lines do not stand even. (18) Mark for a hyphen. (19) No new paragraph. (20) The manner in which the apostrophe, inverted commas, the star, and other references, and superior or "cock-up" letters and figures are marked.

The immediate object of a proof-reader or corrector is to observe and mark every error and oversight of the compositor, with a view to make the printed sheet a perfect copy of the author's manuscript. This is on the supposition that the manuscript itself is quite correct, which is seldom the case; and therefore the duty of a good reader extends to seeing that there are no inconsistencies in orthography, punctuation, abbrevations, etc., and in many cases to the verification of quotations, dates, and proper names. Where extensive alterations, omissions, or additions are likely to be made by writer or editor, it is more convenient to take the proofs on long slips, before division into pages. The making of new paragraphs, or the suppression of those in type, should be avoided as causing trouble and expense.

The duty of securing consistency in spelling and punctuation is especially important in the case of works on which several writers are employed, such as newspapers and cyclopædias. The corrector has also to direct his attention to the numbering of the pages; to the arrangement of chapters, paragraphs, and notes; to running titles, etc. It is part of his business to observe the mechanical defects of the work — defective types, turned letters, inequalities of spacing between words, sentences, and lines, crooked lines, and to secure symmetry in verses, tables, mathematical operations, and such like. In almost all cases two proofs are taken, and in difficult works, such as those in foreign languages, tables, etc., even more. Lastly follows the revision, in which little more is done than seeing that the compositor has made all the corrections marked on the last proof. It is usual for the writer or author to reserve the correction of the second proof for himself. The work of a proof-reader is more difficult than the uninitiated would believe. It requires extensive and varied knowledge, accurate acquaintance with the art of typography, and, above all, a peculiar sharpness of eye, which, without losing the sense and connection of the whole, takes in at the same time each separate word and letter. See PRINTING; TYPOGRAPHY.

Propagan'da, a shortened name for the *congregatio de propaganda fide* (congregation for propagating the faith), founded by Gregory XV. in 1622. It consists of a number of cardinals with the cardinal prefect at their head, has a secretary and five subalterns as heads of five chief departments, and a vast number of inferior agents or employees. It is the central missionary association of the whole Roman Catholic Church, and superintends and guides missionary operations in all parts of the world. Connected with it is the *collegium seu seminarium de propaganda fide*, instituted by Urban VIII. (1627) for the education of missionaries, students of all nationalities being here received and trained and maintained free of expense, from the age of 14 years. Converts to the Roman Catholic Church who have come to Rome are instructed and supported by its funds. Bishops and other clergy who have been missionaries are also welcomed and supported there. The Roman Propaganda has a printing-press, celebrated for the works which issue from it. The efforts of the propaganda are directed particularly to countries outside of Europe. All the earth is divided by it into provinces. In close connection with it stand a number of seminaries or colleges for missionaries in various countries, including England and Ireland.

Propagation of the Gospel, Societies for. See MISSIONS, FOREIGN PROTESTANT.

Propeller. See SCREW-PROPELLER.

Propertius, prō-pėr'shĭ-ŭs, **Sextus**, Latin poet: b. Assisium, Umbria, about 50 B.C.; d. Rome about 15 B.C. He is ranked as the greatest elegiac poet of Rome. He was deprived of his estate in the course of the agragrian confiscations and reduced to comparative indigence. Nevertheless he acquired a good education and was urged to take up the profession of advocate, but seems to have preferred devoting his energies to light literature and affairs of the heart, in which his love for the woman in his poems called "Cynthia" (her real name was Hostia), finally gained the ascendant and is reflected in much of his best writing. Propertius numbered among his friends Virgil and Ovid and engaged the patronage of Mæcenas. With Horace his relations do not appear to have been friendly. He was of a delicate constitution, pale and thin in person and of an emotional temperament in which melancholy seems to have had a large share, particularly in his late years. It is said of him that he was very careful about his personal appearance, almost foppish in his attention to dress and gait. The poems of Propertius consist of a collection of elegies in four books, which, however, contain many gaps and have been in some instances more or less disfigured by corruptions. They are in their outward form modeled somewhat after the manner of the Alexandrine poets Callimachus and Philetas. He excels in the presentation of quiet description and emotion, «a fine and almost voluptuous feeling for beauty of every kind, and a pleading and almost melancholy tenderness.» English translations have appeared by Palmer, Paley, and Postgate. The best texts are those by Hertzberg (1843-5); Keil (1850); and Haupt (1885).

Property, in law, is the right and interest which one has in lands, and chattels, to the exclusion of others; the term includes everything that is the subject of ownership, and in its proper sense the term means tangible things and rights which accompany, or are incident to, the use and enjoyment or disposition of things. Property is usually divided into two classes, real and personal. Real property includes land, and as well, all rights in connection therewith. Personal property may be divided into two classes — absolute and qualified; the former is that which is one's own without any qualification whatever; qualified property consists in the right which one may have in it, but which right is lost when possession or dominion ceases,— such for instance as wild animals. One in possession of goods on which he has a lien, though not the owner, has a qualified property in them, while the owner has the absolute property. Personal property may be in possession or in action; the former being tangible objects, and the latter consists of a legal right,— such as the right to sue. Property is lost through the act of the owner conveying or alienating it, which can be done if the legal capacity to make a contract exists, by absolutely abandoning the title, or by the operation of law, as a forced sale, to complete the fulfilment of an obligation; by confiscation, prescription, capture by public enemy; or property may be lost by the act of God, as in the death of an animal, or by destruction through natural causes. Some classes of property are described as mixed property, that is, not altogether real, or personal, but composed of both,— such for example as heirlooms or monuments. In many jurisdictions of the United States what constitutes personal property is defined by statute. The most important distinction between real and personal property is the fact that real property is generally immovable, including land or anything that is physically attached or affixed to it, and certain things that may ordinarily be regarded as real property, are under some circumstances deemed to be personal property — such for example as the buildings placed on the land of another under an agreement to remove them, growing crops, trees, or minerals in the earth. Personal property may become real property by being attached to the soil. Property is frequently termed a chattel, a term somewhat more extensive than goods. Chattels are divided into two classes, real, and personal, an instance of the former being limited estate in land, and an instance of the latter, any movable property. The ownership of personal property includes the right to use and dispose of it at will, provided such disposition is consistent with the rights of others and the public welfare. Through contract one may become a limited or qualified owner of personal property. In the United States ownership of property and the rights connected therewith are expressly protected by constitutional provisions, the most important of which are to the effect that private property shall not be taken for public use without just compensation, and that no person shall be deprived of property without due process of law; thus, it will be seen, for the public welfare, one may be dispossessed of property if duly compensated. Property may be the subject of legal or equitable ownership; legal ownership being such as would be recognized in a court of law, and is absolute; equitable ownership is the right one has in property which would be protected by a court of equity,— such for example as a lien. Real or personal property may be owned exclusively by one person or by a number. Property is regarded as lost in a legal sense when it has been involuntarily parted with by the owner, and under such circumstances the finder acquires no title as against the real owner, and, therefore, could not transmit the title to another. Legal distinction is drawn between property, and a thing which is merely an evidence of property,— such for example as a bill of exchange (q.v.), or a promissory note (q.v.). Property may be acquired by accession, which is the right to all that one's property produces, and a distinct property right belongs to authors and inventors to the exclusive profit of their productions, which may be protected through the patent or copyright (qq.v.) laws. To this class of property also belongs the right of one to the exclusive use of a trademark. A person who by force or fraud unlawfully takes possession of the personal property belonging to another, or if after obtaining possession of such property unlawfully detains it, can be compelled to return the things taken, or detained, and to pay damages for the loss sustained, or money for the value thereof. There is also a criminal liability fixed by statute relating to personal property, the more important of which are forgery, embezzlement. theft, robbery and receiving stolen goods.

Property Tax. See Taxation.

Prophecy. See Old Testament.

Prophet, or **Soothsayer**, an insect, the praying mantis. See Mantis.

Prophets. See Old Testament.

Propitia'tion, the act or means of making propitious or favorable. It is a Biblical and theological term applying especially to Christ and his death. Saint John (1, ii. 2) says, «He (that is, Christ) is the propitiation for our sins.» The end of all the sacrifices prescribed in the Old Testament was to obtain propitiation, to propitiate an offended Creator. See Atonement.

Prop'olis. See Bee-keeping.

Propon'tis. See Marmora, Sea of.

Proportion, an equality of ratios; a series in which the first of any even number of terms bears the same mathematical relation to the second term as each other odd-numbered term does to the even-numbered term which immediately follows; thus 4, 12; 5, 15; 6, 18 (or 4:12=5:15=6:18, or 4:12::5:15::6:18, these forms being read "4 is to 12 as 5 is to 15 as 6 is to 18," etc.) is a *geometrical* proportion. The definition given above using the words "same mathematical relation" shows that there may be other than geometrical proportions, in which the relation is the fundamental one of multiplication (or division). The fundamental relation of addition (or subtraction) also gives rise to a proportion, the so-called *arithmetical* proportion; thus 4, 6; 7, 9; 11, 14, or, generalizing, a, a + d; b, b + d; c, c + d, are in arithmetical proportion as each odd-numbered term is related to its corresponding even-numbered term by the difference 3. The distinction between geometrical and arithmetical is here the same as in progressions (q.v.), and the proportion is merely a special case of progression. It is perfectly obvious that the concept of the proportion may be applied elsewhere, the relation for example being not that of multiplication (or division) nor that of subtraction (or addition), but that of evolution (or involution); thus 4, 16; 5, 25; 11, 121, is a series in which the analogy between terms 1 and 2, holds in the case of terms 3 and 4, as well as terms 5 and 6, the relation being that of the root to the square. But this general concept of the proportion or analogous relation finds small place in mathematics, even the most modern theory being little fresher than Euclid's Fifth Book, which was derived in part from Pythagoras, and which is, save for the difficulty in the treatment of incommensurables, far superior, though reckoned more difficult, than the numerical treatment which came into vogue in the Middle Ages; Euclid's method is concerned with lines, instead of numbers. To all intents and purposes the modern method like Euclid's is concerned merely with geometrical proportions. In a geometrical proportion the odd-numbered terms are called the antecedents, the even the consequents; the first and fourth terms the extremes, the second and third, the means. A mean proportion has the second and third terms identical as $a : b = b : c$, which may more conveniently be written $\frac{a}{b} = \frac{b}{c}$. The chief properties of a geometrical proportion, say $\frac{a}{b} = \frac{c}{d}$, are the following: (1) the product of the means equals the product of the extremes, $bc = ad$ (clear of fractions); (2) the terms are in proportion by composition, $\frac{a+b}{b} = \frac{c+d}{d}$ (add 1 to each member of the original equation); (3) the terms are in proportion by division, $\frac{a-b}{b} = \frac{c-d}{d}$ (subtract 1 from each member); (4) the terms are in proportion by composition and division, $\frac{a+b}{a-b} = \frac{c+d}{c-d}$ (divide the equation in (2) by the equation in (3)).

Proportional Representation, in politics, a system of representation by which political parties are represented according to their numbers, and not in such a manner as that the majority elects all the representatives. Two plans in particular for securing proportional representation have been tried, the one being by providing that voters shall only vote for a proportion of the representatives, say two out of three, or half when the number is even; the other being to give each elector a vote for every one of the representatives and let them give their votes as they please. In 1900 Belgium adopted a system of proportional representation, and a similar method of election is in operation in some Swiss cantons.

Proposition, (1) in mathematics, a statement in terms of something proposed to be proved or done. (2) In grammar, a sentence, or part of one, consisting of a subject, a predicate, and copula. (3) In logic, a sentence, or part of a sentence, affirming or denying a connection between the terms; limited to express assertions rather than extended to questions and commands. Logical propositions are divided: First, as to substance, into categorical and hypothetical; secondly, according to quality, into affirmative and negative; and thirdly, according to quantity, into universal and particular. (4) In poetry, the first part of a poem, in which the author states the subject or matter of it. (5) In rhetoric, that which is proposed, offered, or affirmed, as the subject of a discourse or discussion.

Propræ'tor. See Proconsul.

Propri'etaries, in American history, a common name applied in colonial days to those local governments instituted in America by the crown, as New York, New Jersey and the Carolinas. Only Pennsylvania, Delaware and Maryland remained such until the time of the Revolution. In proprietary governments, the proprietor appointed the governor, and in general performed all those acts of government which in royal governments were performed by the crown. The laws of Pennsylvania and Delaware were subject to the supervision and control of the crown; those of Maryland were not.

Propyl (C_3H_7), the third radical of the series C_nH_{2n+1}. It does not exist in the free state, but enters into the composition of a large series of important compounds.

Propylæa, prŏp-ĭ-lē'ạ, in Greek architecture, the entrance to a temple. The term was employed particularly in speaking of the superb vestibules or porticoes conducting to the Acropolis or citadel of Athens, which formed one of the principal ornaments of the city. This magnificent work, of the Doric order, was constructed by Pericles (437–433 B.C.) after the designs of Mnesicles, one of the most celebrated architects of his age. Pausanias says it was covered with white marble, remarkable for the size of the blocks and the beauty of the workmanship.

Prorogation of Parliament, in Great Britain, the continuance of Parliament from one session to another, as adjournment is a continuance of the session from one day to another, or for a longer period. Prorogation determines the session; but adjournment does not. After a prorogation any bill which has previously passed both houses, or either house, without receiving the royal sanction or the concurrence of the other house, must be taken up *de novo*. Parliament is prorogued by the king in person, or by his commissioners. See Parliament.

Prosau'ria, a subclass and also an order of Palæozoic reptiles. See Herpetology.

Proscenium, prō-sē'nĭ-ŭm, in Greek and Roman theatres, the place where the actors appeared. The front part of it, where the actors stood, was called in Greek *logeion* or *ocribas*, and in Latin *pulpitum* and was elevated above the rest of the stage. The orchestra was in front of it. The place where the actors dressed and undressed, was called *postscenium*. Projecting wings on each side of the proscenium were called *parascenia*.

Proscrip'tion, in Roman history, a mode of getting rid of enemies, first resorted to by Sulla in 82 B.C., and imitated afterward in the years that closed the republic. It literally signifies "a writing before," and commonly meant an advertisement or announcement of articles to be sold. But Sulla applied it to a proclamation containing names of citizens and promising a reward to any person who should kill those named in the lists, and a threat of death to those who should aid or shelter them. The persons named were said to be proscribed. Their property was confiscated and their children were declared incapacitated for public office. The most notorious proscription after that of Sulla was that posted by the second triumvirate — Antony, Octavius Cæsar, and Lepidus (43 B.C.), in which was included the name of Cicero.

Pros'ecutor, in law, is one who prosecutes another for a crime in the name of the government, whether public or private. A public prosecutor is an officer appointed by the government to prosecute all offenses. In the United States the chief law officers that are public prosecutors are the attorney-generals of each State, and there are subordinate officers known as State, district or county attorneys. A private prosecutor is one who prefers accusations against a person whom he suspects to be guilty, and if he acts from proper motives he will not be responsible to the party in damages, although he was mistaken in his suspicions, but if from a motive of revenge he caused a criminal prosecution without reasonable foundation, he would be liable in an action for malicious prosecution. A prosecuting attorney bringing an action in the name of the people is presumed to have authority.

Pros'elyte (Greek, an arrival or newcomer), he who leaves one religion for another. In New Testament times there were proselytes of two degrees, the proselytes of the gate who renounced idolatry and worshipped the only true God according to the (so-called) seven laws of the children of Noah, without subjecting themselves to circumcision and the other commands of the Mosaic law, and were only admitted to the court of the temple, and stood at the door of the inner temple, whence their name; having the right of dwelling in the land of Israel, but only in suburbs and villages; and the proselytes of righteousness who had been fully converted from paganism to Judaism, had been circumcised, and bound themselves to observe the Mosaic law. Before their circumcision they were examined respecting the grounds of their conversion; after their circumcision they received baptism, being immersed with their whole body in a cistern full of water, on a festival, in the presence of three judges. This baptism, known under the name of proselyte baptism, was repeated in the case of those children of a proselyte who had a heathen mother. Boys under twelve and girls under thirteen could not become proselytes without the consent of their parents, or, in case of their refusal, the aid of the magistrates. By the baptism every one was considered as born anew, so that his parents were no longer regarded as such, and slaves thus baptized were set free.

Proserpina, prō-sėr'pĭ-nạ. See Persephone.

Prosody (Greek, *prosōdia*), the part of grammar that treats of quantity, accent, and the laws of versification. See Rhyme, Rhythm, and Verse.

Prosper (Fr. prōs-pār) **of Aquitaine, Saint**, French poet and religious controversialist: b. Aquitaine about 403; d. later than 463, probably at Rome. He was a layman, probably a teacher of rhetoric and had settled in some city of Provence (perhaps Marseilles) when Augustine's work on ‘Correction and Grace’ reached Southern Gaul. In that country there were many Semi-Pelagians, who taught that Augustine's doctrine of grace militated against the notion of Free Will. Prosper with a companion went to Rome after the death of Augustine in 431 and induced Pope Celestine to write a letter against the Gallican Semi-Pelagians. Prosper also wrote a Latin poem ‘On the Ungrateful’ as he styled the Semi-Pelagians who seemed ungrateful for the gift of divine grace; many essays on ‘Grace and Free Will’ and a most valuable chronicle, which brings the history of the French church down to 455; and he compiled a *Liber Sententiarum* from Augustine's works. Consult: Migne, ‘Patrologia Latina,’ Vol. LI.; Worter, ‘Prosper von Aquitanien über Gnade und Freiheit’ (1867).

Pros'pero, one of the principal characters in Shakespeare's romantic drama, ‘The Tempest.’ He is the rightful duke of Milan, but is dispossessed of his dukedom by his brother Antonio and the king of Naples, and with his daughter Miranda is put adrift at sea in a leaky boat. Having reached a desolate island he establishes a refuge for himself and daughter, with Caliban, a half-human monster, the only inhabitant he found on the island, as servant. He takes up the practice of magic which he had studied at Milan, raises a tempest which wrecks upon his island coast Antonio, the king of Naples and their suites, and saves them from drowning only to subject them to various punishments until he finally reveals himself, and gives them his forgiveness. All prepare to return home, Miranda meantime betrothed to the king's son Ferdinand. Prospero then breaks his wand and renounces magic.

Prossnitz, prŏs'nĭts, Austria, a town of Moravia, in the circle of and 11 miles southwest of the town of Olmütz, on the Rumza. It has extensive manufactures of woolen and linen cloth, cashmere and cotton goods, in all of which it carries on an important trade; numerous distilleries of brandy and rosolio, and one of the largest corn-markets in Moravia. Pop. about 27,000.

Prostate Gland, a pale, firm glandular body, resembling a chestnut, which surrounds the neck of the bladder and the urethra in the male. It consists of two lateral lobes and one middle lobe. Muscular tissue constitutes the proper stroma of the prostate. The excretory ducts from the glandular substance of the organ open into the prostatic portion of the urethra. It is well supplied with blood-vessels and nerves and is enclosed in a thin but firm fibrous capsule. Enlargement of one or more lobes of the prostate is very common in men over 55. The cause is not known. It is said that it has never been found in eunuchs, or where the testicles have been lost. The enlargement encroaches on the rectum and urethra, interfering with their functions, the bladder becoming distended; its walls may be thin and inefficient and a cystitis may be set up. In this disorder the stream of urine becomes slower; there is a frequent desire to urinate, even at night, but only a few ounces of urine are passed each time. Exhaustion, sepsis from retained urine, and sometimes local hemorrhage cause enlarged prostate to be a serious condition. Treatment includes mild and easily digested food, regulation of the bowels, freedom from exposure to cold and damp, and the careful use of the catheter. Sometimes enucleation of the enlarged gland (prostatectomy) is of value; so are Bottini's operation, burning a channel through the obstructing mass, and vasectomy, the cutting of the vas deferens. Removal of the testicle to reduce the size of the prostate is sometimes resorted to. Acute prostatitis, an acute inflammation, is most often due to gonorrhœa or to strong injections for its relief, but may arise from the irritation of calculi or the use of instruments, etc. The symptoms are painful and frequent micturition, swelling, high fever, retention of urine, and tenderness in the region of the lower bowel and the neck of the bladder. The inflammation may progress so far that suppuration (prostatic abscess) occurs. The treatment requires rest in bed, hot anodyne fomentations, leeches, purgation, and opening of an abscess. Chronic prostatitis may be the sequel of the acute form, or it may be primary. There is less swelling, pain, and tenderness than in the acute. It is a condition which needs the supervision of the physician or surgeon. Tubercular disease of the prostate may either be primary or be secondary to similar disease of the testes. There are nodular lumps, which may break down and produce an abscess. The disease may invade the bladder and the whole urinary tract. The prostate is subject to malignant tumors, carcinoma, and sarcoma. Prostatic calculi about the size of millet-seed are quite common in old men. They rarely give rise to symptoms unless inflammation occurs. Sometimes they are voided, or they may form the nucleus of a prostatic calculus.

Prostyle, in architecture, a portico in which the columns stand in advance of the building to which they belong. The term *amphiprostyle* is used when there is such a portico attached to a building both in front and behind.

Protagoras, prō-tăg'ō-ras, Greek sophist: b. Abdera, Thrace, about 480; d. 410 B.C. He studied the old Ionian philosophy paying especial attention to Heraclitus, and he was the first to assume the title of Sophist, and to teach for pay, a practice which, Plato informs us, proved very remunerative. He taught principally at Athens. When, about 443, a number of Athenians left the city to join in founding the new colony of Thurium, Protagoras was appointed by Pericles to accompany them and subsequently drew up a constitution for the Thurians. Before returning to Athens he lived for some time in Sicily, where he acquired great fame. He returned to Athens before 430. In 411 he was brought before the Areopagus for beginning one of his works ('Concerning the Gods') with the words, "Respecting the gods, I am unable to know whether they exist or do not exist," was banished for atheism, and perished at sea. He was the author of a large number of works, all of which are lost. The two most important of them were the one already mentioned, and another entitled 'Truth.' One of the dialogues of Plato bears the title 'Protagoras,' and yields some information regarding his mode of teaching. His famous apophthegm, *ἄνθρωπος μέτρον* (man is the measure of all things) has become the eternal possession of philosophy and can never lose its significance. Man from his subjective impressions can, he said, decide what things are, and what things are not. Hence he taught that Science was impossible and Opinion everything. This was what in modern philosophy corresponds to Sensualism. For these views he was controverted by Socrates and the Socratic school. Consult: Lewes, 'History of Philosophy'; Herbst, 'Protagoras, Leben und Sophistik' (1832).

Protection is a term in political economy, employed to describe the policy of indirectly promoting the growth of national industries, either to secure the defensibility of the country in time of war, or to promote its general welfare, or both. It differs from Socialism in seeking this by indirect means, and with the minimum of interference with individual freedom, recognizing that the true function of government is to steer the ship of state in industrial matters, and not to propel it. It differs on the other side, from free trade, which excludes government from any kind of activity in the industrial sphere, and especially objects to any legislation which will have the effect of diverting capital and labor into channels in which they would not otherwise flow.

More than one way to this end has been used, such as the absolute prohibition of specified imports, premiums upon exports, bounties upon home production, and the retention of raw material. But the usual way has been to impose, upon the competing product from abroad, a duty sufficient to discourage its use and to make it unprofitable to the dealer. Such duties are either *ad valorem* or specific. The former are levied upon the value of the imported commodity, and are either directly or inversely proportional to that value. Thus the duties imposed by the British Corn Laws rose as the price of wheat fell, and the converse. Specific duties are those which tax the commodity by number, weight or bulk, irrespective of differences in value. For protective purposes there are preferable.

From the rise of national feeling in Europe, at the close of the Middle Ages, to the Congress of Vienna in 1815, all governments pursued the policy of protection to home industry. Among economic theorists a protest against this was begun by the French *Economistes* (Gournay, 1754; Quesnay, 1758; Turgot, 1766). It found its finest exposition and defense in their Scotch disciple, Adam Smith (1776), who contended that the interplay of self-interest is quite sufficient to secure the best industrial development, and that when every man is left to «do as he will with his own,» he will do what is best for society. The antipathy of Napoleon I. to this theory, and the questionable means he employed to counteract it in his Continental System, seemed likely to give it a chance of being applied in the states represented at the Congress of Vienna. But a few years of actual experience satisfied the rulers and cabinets of the Continent that the path to national prosperity did not lie in that direction. They returned to protection, which England and France, indeed, never had abandoned, and which Germany made effective for the whole country through the Zollverein (1817).

It was in the United Kingdom, in 1846, after eight years of popular agitation by the Anti-Corn-Law League, that a European government first took steps to abandon Protection, and that after 510 years of it had lifted England out of the dire poverty of a merely agricultural country, into the first rank among manufacturing nations. And even she continued to protect her silk and glove industries against French competition, until the Cobden Treaty of 1860 agreed to the abolition of these duties.

In America the need of a national government, which could extend protection to the prostrate industries of the States, was one of the most powerful motives to the formation and adoption of the Constitution of 1787, which authorized Congress to impose duties on imports «to pay the debts and provide for the common defence and general welfare of the United States.» The harsh experiences of the war for independence had shown the country the need of manufactures for the defense of the nation. It was on this ground that Washington repeatedly pressed for adequate legislation; and in this he was supported by his secretary of the treasury, Alexander Hamilton.

Duties were steadily adapted to this end, until the political revolution of 1801 brought Jefferson into office. From that time no advance in the direction of more adequate protection were made, although only the duty on salt was repealed, with the result that the country had a second salt-famine during the war of 1812–15. Its sufferings in this, and other industrial wants, effectually converted Jefferson from free trade, but it was not until 1824 that the country returned to an effective protective policy.

The South, however, found that its adhesion to slavery precluded it from entering upon manufactures, and now began to antagonize protection as an encroachment on the rights of the States, although her cotton-growing industry had been brought into existence and advanced to prosperity by a protective duty continued for many years. Her threats of nullification led to the adoption of the tariff of 1833, which provided for the gradual reduction of all duties to a 20 per cent level by 1840. The general suspension of manufacturing through this reduction and the derangement of the currency brought about the severe depression of 1837–42, and caused another political revolution in the election of a Protectionist Whig to the presidency in 1840.

During the four years of the tariff of 1842 there was a great and general restoration of prosperity; but the influence of the example set by England, and the prospect of open markets in that country for western and southern products, brought about another change. The tariff of 1846 embodied no economic principle, but effected a large reduction of duties below the protective level. In 1857 these duties were farther reduced by one fourth, and another severe depression of industry helped to the election of Mr. Lincoln in 1860. Before he came into office the Morrill tariff had been passed by Congress and signed by President Buchanan.

This was done in view of the certainty that a civil war at home was impending, and that it might involve the country in hostilities with England and France. It was therefore felt necessary to put the country in the way of equipping itself for any emergency. The relation of home industry to national defense thus indicated, was amply shown in the distresses and disabilities of the Southern Confederacy, which solemnly committed itself to free trade in its Constitution, and was dependent upon its friends in Europe for military and other supplies. For over 30 years our country persisted in the policy of protection, with some unhappy experiments in the reduction of duties,— notably those on wool and woolens in 1883. The presence of a surplus of revenue in the national treasury was made the pretense for demanding «Tariff reform,» meaning an advance toward free trade. In spite of partial victories, nothing was effected until after Mr. Cleveland's second election in 1892. The tariff of 1893 fell far short of what he and his friends wished, but it went as far beyond what the country would endure, and brought about a reaction and a return to Protection, which the country gives no sign of abandoning at an early date.

The Reasons for Protection are numerous and mutually supporting. (1) The necessity of varied industries for the national defense has been indicated already. It was again shown in the Boer war, in which a brave people were handicapped by their being a merely agricultural population, in conflict with a great manufacturing country. It may be illustrated, in the opposite way, in the next great European war which involves Great Britain, through that country's long neglect of her agriculture exposing her to the gravest perils. A single defeat of her navy may result in rendering it possible for an enemy to starve her people into submission. (2) The variety of industry, which Protection establishes, is not less necessary to defend the country from the perils of famine. A country which produces food only, is liable to famine and its consequent pestilences, whenever the rains are too scanty or too plentiful for the harvesting of the crops. Such a country has all its eggs in one basket, and should that fall, it has nothing to fall back upon. Ireland and India became famine countries through the destruction of their manufactures by English legislation and by English competition. They will remain such until they secure the independence which will enable them to enact the protection to their home industries they both desire. All the regions visited by famine in modern times — Persia, central Russia, northern China, northern Sweden, Asia Minor, and even some districts of our own country,— are merely agricultural communities. (3) Protection secures the general welfare of the producers of the country, by bringing each class into the neighborhood with the others, which supply its wants and demand its goods. It thus saves the cost of carrying products over land and sea to find a market, and bring back, at a like cost of carriage, whatever is taken in exchange. The railroads of this country save about $5 a ton on having their worn rails converted into new, through not being obliged to send them to rolling-mills in Europe. The farmer gets more for his crop when he has the artisan close at hand to consume it, and obtains in greater abundance what the artisan produces, even if he has to pay a higher money-price for it. All this advantage is lost when a country keeps its farms on one continent and its workshops on another, and spends both strength and money in transportation which could be avoided. (4) The naturalization of varied industries by protection gives the people of the country greater liberty to choose the kind of work they prefer, and a finer opportunity to develop their natural capacities in improving old methods or inventing new ones. This has been especially true of America, whose people were taunted for their backwardness in invention before this became a manufacturing country. An English manufacturer declared we could not make so much as a mouse-trap for ourselves. American inventions have lightened the burden of toil for half mankind. They have made many staple articles, such as steel, cutlery, cottons and silks, cheaper to the whole world. The American character has been distinctly improved by emergence out of the stage, at which farming and shipping furnished almost the only employments, and has grown in manifoldness and energy. (5) The variety of industry, at which Protection aims, is highly useful in drawing the people of the country in closer relations, and thus contributing to the unity of will and understanding, which underlie national unity. It was by the trade between the English colonies that the fierce prejudices of our earliest time were overcome. It was through the development of foreign commerce at the expense of home trade that the Union was imperiled. As Mr. Carey showed Mr. Lincoln, our railroad lines ran only to the seashore, to facilitate exports and imports. They now run north and south as well. By the Zollverein and its fostering of home trade, Germany was helped to national unity. The English sneered at the notion that the Germans could “spin and weave themselves into national unity,” but the result came. (6) By preventing adverse balances of trade, Protection guards the national supply of solid money from being drained out of the country. Money is “not a commodity like any other,” as to whose incoming and outgoing we can afford to be indifferent. It is the means of organizing labor for the conquest of nature and the production of wealth. And it is not indefinitely replaceable, as are many other commodities. To exchange it for hardwares and textiles is to exchange power itself for the products of power. Laveleye compares such an exchange with that between two parties of hunters, who should trade game for guns and ammunition, while at a distance from the basis of supply. Nor is it true, as some economists tell us, that the loss of gold and silver have no other effect than to lower prices in the country which exports them, and thus lead to a return of coin by purchasers from abroad. Prices are lowest in the countries which have the most money, because labor is organized there to the best advantage, and is thus made more productive. “Start a shilling in Thibet, and it will turn up in London.” It goes to where it will buy more commodities, though less labor. Therefore is it true that the gold of the world tends constantly to the great centres of money and of manufacture, moving on the same lines with the commerce in food and raw materials. By refusing this unequal commerce, we have ceased to be a gold-exporting country, and have thus obtained that stock of money which enables us to organize labor on a great scale, and acquire industrial power.

The Objections to Protection are many in form, but they resolve themselves into a few. (1) It is charged that “protection is hostile to commerce. If we do not buy, we cannot sell. Thus we are deprived of the possibility of disposing of our surplus products.” But with the single exception of England since 1846–60, all the great commercial nations have practised protection; and under that policy our own exports have reached a figure not equaled by any other country in the world, our rate of progress in this respect being rivaled only by protectionist Germany. In truth, nations buy of each other just what they must, and sell all they can, and means of payment are always found. (2) It is objected that “the interest of the consumer is that of society at large, while the interest of the producer is that of a class only. Free trade promotes the former, while protection seeks the latter. For the consumer is interested simply in getting what he uses as cheap as possible, and with this a protective duty must interfere.” But “better than a low price for any article is a fair price,” Mr. Lowell says. The times of especial cheapness are what we call “hard times,” and even the free trader fails to recognize his own ideal in those times. Like other people he begins to talk of an “improvement in prices,” meaning a rise. In considering the effect of protective duties upon prices it is necessary to look at both sides of the account. Nearly every one in the community has something to sell, and it is of small use to him to be able to buy at a low rate, if he must sell at a still lower. Ireland is a land of cheapness, but not to the advantage of its people, who cannot find a market for their labor. Nova Scotia is another country of low prices, and its people flock in thousands to Massachusetts, to seek employment at such wages as they never can earn at home, and to live in a comfort there denied them. The free trader fixes attention far too much on one side of the account, to the neglect of the other. Nor is the consumer, in the long run, obliged to pay higher prices because of protection. Mr. Greeley used to challenge the free traders to mention a single article whose manufacture had been protected for 14 years, without falling in price below the point at which it has stood. All kinds of commodities in this country are cheaper to the consumer than they were before the enactment of the Morrill Tariff. The national consumption of all has increased far more rapidly than the increase of the population. (3) It is alleged that «Protection is but a method of forcing a hot-house growth of industries, which would have come to us naturally, when our density of population warranted the transition from farming to manufactures. The latter arise when there is a real need and demand for them, without any interference on the part of government.» This statement is not supported by any historic instances of this natural growth. Every nation, which now possesses such industries, made its beginnings under Protection. Every great industry that is fighting for the markets of the world, was built up by protective duties. On the other hand, everyone admits that the want of manufactures is the root of the misery of Ireland and of India. The governmental commission to investigate the cause of Indian famines, reported, in 1885, that nothing but the diversion of a large part of the labor of the people to manufactures would put an end to them. The need of both countries is beyond question, for in both the density of population has passed the point at which people can live by the soil. But neither of them possesses the power of transforming mere need into effective *demand,* by native legislation. How long are they to wait for that «natural growth?» (4) Adam Smith's argument from the beneficial effects of what he called «natural liberty,» supposes that «individual self-interest is enough to secure all the industrial growth that any country needs or should want. If everyone be left free to do as he will with his own, he will do what society needs to have done.» Those who repeat this argument are never willing to apply it to other forms of the state's activity, which affect industry. They do not propose to have the merchants of each seaport keep its harbor in condition by their individual or even their united action. They dare not assert that individual self-interest has not inflicted deep and lasting injury of our country in the devastation of its forests, the destruction of its game, and especially the extirpation of insect-destroying birds. They sustain the government in making the coinage of money and the carrying of letters public monopolies, and punishing all who invade either. They have ceased to look to private self-interest for the maintenance of a school system adequate to our national need. They make all these exceptions to their own theory, and the protectionist adds one more. Adam Smith's principle, however, has great truth. It is the rule, and all these other things are the exception. The protectionist differs from the free trader in that he has no panacea or cure-all to offer to the public. He has only a specific for a single social defect, and he alleges in its favor that it interferes as little as possible with personal liberty. (5) It is objected that «protection favors the manufacturers at the expense of their laborers and of the farmers of the country.» As for the laborers, protection does not set aside the law which Carey, Bastiat and Atkinson have shown to govern the distribution of profits. The laborer's share of the joint-product of capital and labor constantly increases, while that of the capitalist constantly diminishes. Protection makes that joint-product greater with every expansion of industry, and thus secures to the workman a higher standard of living and a greater opportunity to save. Between 1860 and 1880, the wages of labor, measured in the power to purchase the staple commodities, more than doubled in this country. While free labor in America was once little if anything above the slave's level, as to the enjoyment of the necessaries and comforts of life, it is now on the highest level that it ever has attained in history. The farmer is directly cared for in the tariff, being secured that great market for his produce which our manufacturing districts furnish him. From that market the protective tariff shuts out his Canadian competitor, in spite of the demand of our free traders, seconded by some short-sighted manufacturers, that we shall return to the reciprocity which existed from 1854 till 1867. The farmer is also benefited indirectly by having his market for produce brought into his neighborhood, thus making his exchanges more equal. As an English newspaper put this years ago, «when the western farmer in America had free trade, he gave a pound of butter for a pound of nails. But under protection he gets 14 pounds of nails for his pound of butter.» (6) It is alleged that «protection favors the formation of trusts, and thus destroys that domestic competition, which the protectionist himself relies upon to secure reasonable prices.» Yet a large number of our trusts, beginning with the Standard Oil Company, are almost independent of the tariff. ?? Of the rest, very few have been able to secure such a control of production as to have the power to dictate prices; and of these several avoid attempting it. Their especial product is as cheap as before the trust was formed, their new gains coming from the saving of expenses. Others still are international trusts, of the sort that would be sure to arise if we abandoned protection. Nor are the countries which practise free trade characterized by unlimited competition among producers. Wherever the trades-union has obtained the control of the rate of wages and of the hours of labor, capitalists have been led to combine for mutual protection. They naturally think that they cannot afford to buy labor in a close market and sell their product in an open one. Unified control has come to be the rule in the great English industries, and they have improved upon our example by including the workingmen in their arrangements for adjusting prices and wages.

The general movement of American industry to better conditions under the protective policy is shown by some statistics of our national position at the beginning of our longest period of protection and the close of the 19th century:

	1860	1900
Population	31,443,321	76,304,799
Aggregate wealth ...	$14,183,000,000	$64,120,000,000
Share per capita.....	$454	$832
Exports	$333,576,057	$1,394,483,082
Imports	$353,616,119	$849,941,184
Wages	$378,878,966	$2,330,273,021
Wage earners	1,311,246	5,321,087
Average earnings ...	$289	$438

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Robert Ellis Thompson,
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Protective Coloration. See Coloration, Protective.

Protector, in the history of England, a person appointed to act as regent generally during the minority of the king. Those on whom it was conferred were the Earl of Pembroke, in 1216, during the minority of Henry III.; Humphrey, duke of Gloucester (1422–47), during the minority of Henry VI.; Richard, duke of York, February 1454 to February 1455, and November 1455 to February 1456; Richard, duke of Gloucester, in 1483, before the death of the young princes, his nephews, and his own accession to the throne; and the Duke of Somerset (January 1547 to October 1548), during the minority of Edward VI. On the 12th of December, 1653, the title of lord-protector was bestowed upon Cromwell, as head of the Commonwealth of England, by the council, composed mainly of his principal officers, which then held the chief power.

Protectorate, a term applied to the relationship existing between a stronger nation and a weaker one when the former undertakes to protect the latter from hostile invasion or other form of aggression and in consequence exercises more or less control over its domestic and foreign affairs. The term is also applied to the state thus protected. The relation between a protectorate and its protector is usually established by treaty, although sometimes it is the result of mere understanding only. At the present time most of the protectorates of the world are to be found in Asia and Africa and the islands of the Pacific Ocean. Notable examples of existing protectorates are Tunis in North Africa, under French protection, and North Borneo, Bechuanaland, Somaliland, British Central Africa, and British East Africa all under British protection. Germany and Italy also maintain protectorates in Africa. Contrary to the general opinion the United States has from early times exercised similar control over weak nations in various parts of the world. One of these was Liberia on the west coast of Africa and founded by the American Colonization Society in 1820. It has been understood all along that no other nation would be permitted to annex it or interfere in its affairs. Likewise Hawaii for a short time occupied the position of a protectorate until its annexation to the United States in 1898. From 1882 to 1897 the United States was one of the three powers to exercise a protectorate over the Samoan Islands. Likewise from 1836 to 1845 it exercised a protectorate over the Republic of Texas. From 1846 to 1903 the United States as a result of treaty with Colombia exercised a quasi protection over the Isthmus of Panama for the purpose of insuring the neutrality of the Panama railroad. Partly as a result of American aid Panama seceded from Colombia in the latter year and virtually placed itself under the protection of the United States. The most perfect example of an American protectorate at the present time is that of the Republic of Cuba, which secured its independence of Spain in 1898 chiefly through the intervention of the United States and which upon demand of the American government inserted in its constitution a promise not to enter into foreign relations with any other country without the consent of the United States and accepted other conditions which materially impair its independence.

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Proteids (from «protein,» q.v.), a large group of organic compounds, of which egg albumin may be taken as a typical example. They are mostly amorphous and indiffusible, and they possess a complicated chemical structure, whose nature is not yet understood. Gamgee describes the proteids, as a class, as follows: «Proteids are highly complex, and for the most part noncrystallizable compounds of carbon, hydrogen, nitrogen, oxygen, and sulphur, occurring in a solid viscous condition, or in solution, in nearly all the solids and liquids of the [animal] organism. The different members of the group present differences in physical, and to a certain extent in chemical, properties; they all possess, however, certain common chemical reactions, and are united by a close genetic relationship.» Proteids occur in the vegetable kingdom, as well as in animals. They are built up, in plants, from simpler compounds; but the animal system is believed to be incapable of performing a synthesis of this kind, and the proteids that occur in the animal body are believed to be derived wholly by a modification of those that are taken into the system in the form of food. The proteids in the food are converted, by the action of such digestive ferments as pepsin and pancreatin, chiefly into soluble substances known as «peptones,» and these, after absorption through the intestinal walls, are (in large measure) transformed into the proteids that normally occur in the muscles and other tissues of the animal. Some of the proteid portion of the food is believed, however, to be transformed, in the course of digestion and assimilation, into glycogen and fat. In the changes which are inseparably associated with the life of the animal, the proteids that are stored in the body (and especially those in the muscular and nervous systems) undergo a process of oxidation, or slow combustion, by which they are transformed into other compounds that are much less highly organized; the ultimate products of this oxidation being mainly water, carbon dioxid, and urea.

The proteids, as a class, are very similar to one another in their ultimate composition, so that Gerhardt believed them to consist mainly of one fundamental albumin-like substance, mingled, or perhaps chemically combined, with varying amounts of inorganic matter. This view is not in favor among the chemists of to-day, although it can hardly be said to be absolutely disproved. Analysis shows that the percentages of carbon, hydrogen, nitrogen, sulphur and oxygen in the various proteids are mostly confined within the following limits: Carbon, from 51.5 to 54.5 per cent; hydrogen, from 6.9 to 7.3 per cent; nitrogen, from 15.2 to 17.0 per cent; sulphur, from 0.3 to 2.0 per cent; and oxygen, from 20.9 to 23.5 per cent.

The proteids are mostly amorphous, although a few are known that are capable of crystallization. They are all insoluble in absolute alcohol, but many of them are soluble in water, or in dilute saline solutions. Dissolved proteids all rotate the plane of polarization of polarized light to the left, the extent of the rotation varying with the nature of the dissolved proteid. Dissolved proteids are not diffusible, as a rule, and mineral matters with which they may be mixed can therefore be removed by placing the solution in a vessel which is separated into two parts by a vertical porous membrane, pure water being placed in one compartment, while the solution to be dialyzed is placed in the other. The mineral salts will diffuse through the porous membrane, while the proteid remains in the compartment in which it was originally placed. By renewing the water in the second compartment from time to time, the dialysis may be caused to proceed until practically the last trace of mineral matter has been removed from the proteid. The peptones, however, are themselves diffusible, and the proteoses (or «albuminoses») are so to a lesser extent.

Many of the proteids that are soluble are precipitated from their solutions in a permanently insoluble condition by the action of heat, the substance which is thus thrown down being known as «coagulated proteid.» The temperature at which heat-coagulation takes place varies with the nature of the proteid, and (to some slight extent) with the degree of acidity or alkalinity of the solvent from which they are thrown down. The fibrinogen of the blood, for example, coagulates at about 133° F.; while serum albumin and egg albumin coagulate at 162° F., and crystallin at 199° F. When a proteid is precipitated from solution by heat, the liquid from which it was thrown down almost invariably has its alkalinity increased, or its acidity diminished. Dry proteids may be brought into the «coagulated» condition by raising their temperature to 230° F.

Coagulated proteids are exceedingly insoluble, and in fact cannot be brought into solution at all except by the action of some agent which changes their chemical nature profoundly. Pepsin (in an acid medium) or pancreatin (in an alkaline medium) convert them into soluble peptones, when the experiment is performed at a temperature not greatly different from that of the human body. A proteid which is precipitated from its solution by alcohol is not at first thrown into the «coagulated» condition, but passes into it gradually upon prolonged contact with the alcohol. When a solution of proteids is saturated with ammonium sulphate, all of its proteids are precipitated except the peptones; but the precipitate is not in the coagulated form, for it is capable of dissolving again, either in pure water or in a dilute saline solution. This reagent is used, in the laboratory, for estimating the amount of proteid in a given solution; the precipitate that it gives being removed by filtration; washed with a saturated solution of ammonium sulphate; heated to 230° to produce coagulation; and finally weighed, after the ammonium sulphate has been removed by thorough washing with pure water, and the precipitate has been dried. Many of the salts of the heavy metals (basic acetate of lead, for example), precipitate proteids from solution by forming, with them, an insoluble proteo-metallic compound. From this compound the metal may be subsequently removed by the action of sulphuretted hydrogen gas; the proteid then being set free in its original, soluble state.

Of the chemical reactions manifested by the proteids as a class, the following may be especially mentioned: (1) *The xanthoproteic reaction.* When nitric acid is added to a solution containing a proteid, the proteid is often (but not invariably) precipitated; and when the liquid is boiled, both the precipitate and the solvent turn yellow from the formation of xanthoproteic acid, the precipitate dissolving upon prolonged boiling, if the nitric acid is present in excess. The yellow color changes to an orange upon the addition of ammonia. (2) *Millon's reaction.* «Millon's reagent,» which is one of the best tests for detecting the presence of a proteid, is prepared by dissolving mercury, by the aid of gentle heat, in an equal weight of nitric acid of specific gravity 1.4. When the metal has entirely dissolved, the solution is diluted with twice its bulk of water, and the abundant precipitate which comes down is allowed to subside. The clear liquid remaining is the reagent desired. Millon's reagent throws the proteids down in the form of a white precipitate; and both the precipitate and the solution become brick red upon boiling, though time is sometimes required before the coloration is complete. Solid proteids give this same reaction, when boiled with the test solution. Tyrosine and silk respond to it also.

The classification of the proteids is a difficult matter, and no scheme that has yet been proposed is free from objection. Halliburton's classification, which has been widely adopted, follows:

(1) *Albumins.*— Proteids which are soluble in water; which are not precipitated when their solutions are saturated with common salt, or with magnesium sulphate; and which are coagulated by heat. Egg albumin and the albumin of blood serum are the most important examples.

(2) *Globulins.*— Proteids which are insoluble in pure water, but which dissolve in dilute saline solutions, from which they are again precipitated in the uncoagulated state, when common salt or magnesium sulphate are added to saturation. Heat coagulates them. Myosin, fibrinogen, serum globulin and crystallin are important examples.

(3) *Albuminates.*— Compounds of proteid bodies with metallic bases, or with acid or alkaline radicals. When a small quantity of dilute acetic or hydrochloric acid is added to an albumin or a globulin, the proteid gradually combines with the acid, forming a loosely-connected compound which is no longer coagulable by heat, and which is known as «acid albumin.» Acid albumin is soluble in dilute acids or alkalies, but insoluble in a neutral menstruum. When the original proteid is treated with a small quantity of dilute alkali, it combines with the alkali to form «alkali albumin»; and this, like acid albumin, is soluble in weakly acid or alkaline media, but insoluble in a neutral one. Alkali albumin is likewise not coagulable by heat. The combinations here described may be taken as typical of the albuminates in a general way; but as the albuminates are doubtless very numerous, and as they have not yet been fully investigated, it must not be inferred that they will all possess the characteristics of ordinary acid and alkali albumins.

(4) *Proteoses,* or *Albuminoses.*— Proteids derived from the albumins or globulins or albuminates by the action of digestive ferments, such as pepsin and trypsin. They are intermediate between the original proteids and the peptones into which these original proteids are ultimately transformed by the digestive ferments. They are precipitated from solution by nitric acid, the precipitate dissolving upon application of heat. They are also somewhat diffusible, but not to the same extent as the peptones.

(5) *Peptones.*— Proteids which are formed by the prolonged action of digestive ferments upon other proteids. (Compare the «proteoses,» in the preceding paragraph.) They are readily soluble in water, and are not precipitated by heat, nor by nitric acid. They are precipitated, however, by tannin, and by certain other reagents. The peptones are diffusible, and they play an exceedingly important part in digestion and assimilation. Peptones that are artificially prepared are commonly bitter, perhaps from the development of alkaloids or glucosides. Pure peptone has a meaty flavor.

(6) *Insoluble Proteids.*— This class includes those proteids which are markedly insoluble. It is hardly a logical division, because it includes many substances that have little in common save the one characteristic of extreme insolubility in all ordinary solvents. Fibrin, gluten, and coagulated egg albumin are examples.

Protein (Greek, «first»), a hypothetical substance whose existence is not now admitted, but which was formerly believed to be an essential part of albumin, casein, and other nitrogenous organic bodies. See PROTEIDS.

Proteran'thus. See GILLENIA.

Protero'glypha. See OPISTHOGLYPHA.

Protesilaus, prō-tĕs-ĭ-lā'ŭs, Greek hero, son of Iphiclus, king of Phylace, Thessaly. He led a band of Thessalian warriors against Troy and was the first of the Greeks to land on the Trojan coast, whereupon he was killed by Hector. Another tradition makes Achates slay him. He is famed in ancient story for the affection which existed between him and his wife Laodemia who, when she learned of his death, prayed that he might return to her for three hours. The prayer was granted and Hermes conducted Protesilaus to the upper world. At the end of the three hours Laodemia died with her husband and returned with him to the lower regions. His tomb was near Eleus in the Thracian Chersonesus, a temple was erected to him there, and at Phylace a sanctuary was built in which funeral games were played in his honor. The story is told by Wordsworth in one of his most beautiful poems.

Protest, a solemn declaration of opinion, commonly against some act, particularly a formal and solemn declaration, in writing, of dissent from the proceedings of a legislative body, or a like declaration of dissent by a minority of any body against the proceedings of the majority. In commerce, a formal declaration, made by a notary public, under hand and seal, at the request of the payee or holder of a bill of exchange, for non-acceptance or non-payment of the same, protesting against the drawer and others concerned for the exchange, charges, damages, and interest. This protest is written on a copy of the bill of exchange, and notice is given to the drawer and endorsers of the same, by which they become liable to pay the amount of the bill, with charges, damages, and interest. (See BILL OF EXCHANGE.) A protest is also a writing, attested before a notary public, a justice of the peace, or a consul in foreign parts, drawn by a master of a vessel, stating the severity of a voyage by which the ship has suffered, and showing that the damage was not owing to the neglect or misconduct of the master.

Protestant Episcopal Church, The, the American branch of the Anglican Communion The Church in America, though quite independent, is in full communion with the Church of England and inherits her ecclesiastical position. As the Preface to the Prayer Book states: «This Church is far from intending to depart from the Church of England in any essential point of doctrine, discipline or worship; or further than local circumstances require.» To define her principles and position is to define Anglicanism, to interpret that movement in history known as the English Reformation.

In the beginning of the 16th century the Church of England was in full communion with the national churches of western Europe, acquiescing with them in the headship of the Church of Rome. In doctrine and discipline she had become identified with the prevailing type of Latin Christianity. By the end of the 17th century she had withdrawn from the Roman obedience and had gradually come to assume the position she maintains to-day. This period of transition constituted the Anglican Reformation. The status of the Church of England was unique. Positively, the change involved a reassertion of the principles of primitive Christianity and an assimilation of the newly-awakened tendencies of modern thought. Negatively, it involved the repudiation on the one hand of mediæval Roman Catholicism, on the other of Continental Protestantism. Anglicans believed that the change involved no breach in the continuity of the English Church. They maintained that in rejecting much that was Roman and mediæval, they had forfeited nothing essentially Catholic.

The American Church inheriting this position claims to be a branch of the primitive Catholic and Apostolic Church. At the same time she is frankly opportunist in adapting herself to the needs and conditions of modern life. In the sense of being not-Roman, she is Protestant. As maintaining that her continuity with the ancient Church is guaranteed by her possession of the Apostolic succession of bishops, she is Episcopal. She is Episcopal also in the sense of being not-Papal. This, perhaps, gives the rationale of her common legal title. Members of the Church are spoken of indifferently as Anglicans, Episcopalians or Churchmen.

The fundamental principles of Anglicanism as well as Anglican terms of inter-communion are indicated in what is known as the Chicago-Lambeth Quadrilateral. In 1886 a Commission on Christian Unity reported to a General Convention held at Chicago. The substance of their report was embodied in a Declaration of the House of Bishops. Two years later, this Declaration was, with slight modifications, adopted by the bishops of the whole Anglican Communion, meeting in conference at the Archbishop of Canterbury's palace in Lambeth. The wording of this Anglican Eirenicon, defining the essentials of the Christian faith, is as follows:

«1. The Holy Scriptures of the Old and New Testaments, as containing all things necessary to salvation, and as being the rule and ultimate standard of faith;

«2. The Apostles' Creed, as the Baptismal Symbol, and the Nicene Creed, as the sufficient statement of the Christian Faith;

«3. The two Sacraments, ordained by Christ Himself — Baptism and the Supper of the Lord — ministered with unfailing use of Christ's words of institution and of the elements ordained by Him;

«4. The Historic Episcopate locally adapted in the methods of its administration to the varying needs of the nations and peoples called of God into the Unity of His Church.»

This Declaration may be taken as an official indication of the bases of the Anglican position.

It is the belief and hope of Anglicans that the position gives them good vantage-ground for promoting the cause of Christian unity. They have much in common with all bodies of Christians. While their attitude toward Roman Catholics is one of resolute protest, their quarrel is only with a mediæval Romanism by which they believe that the primitive Catholicism of the great Latin Communion has been obscured. Their position more nearly approximates that of Eastern Orthodox Catholicism — Greek Christianity — and that of the Old Catholics. Their relations with both these communions are those of friendly interest and intelligent sympathy, although there is no inter-communion nor immediate prospect of it. The many differences due to widely differing antecedents oppose difficulties to the adoption of a common platform. This, however, does not prevent many manifestations of present friendship and hope of closer relations in future. Recent years have seen a marked rapprochement between the Anglicans and the Russian Orthodox Communion.

On the other hand, the Anglican Church is in close sympathy with the life and aims of various bodies of Protestants. Her breach with the Christian past is not so great as theirs but she rejoices to feel that the fundamentals of her faith are the same as theirs, and that she is at one with them in striving to adopt and apply Christianity to the needs of modern times. Since the appointment of a Commission on Christian Unity in 1856, there have been conferences with the Presbyterian General Assembly, the General Synods of Evangelical Lutherans of the North and the South, and the Provincial Council of the Moravians. These have contributed somewhat to a better mutual understanding. Some idea of the nature of the Anglican claim and hope is necessary at the outset for an appreciation of the details of Anglican history.

The Church of England in the American Colonies.— The Church of England came to America with the first English explorers and colonists. The first English service, so far as is known, was held in 1579 on the coast of California by the Rev. Francis (or Martin) Fletcher, ship's-chaplain to Sir Francis Drake. In 1607 an English clergyman was regularly established among the Virginia colonists at Jamestown. This missionary was the Rev. Robert Hunt, a man of simple piety and great zeal, who held daily services in the open air and on 21 June 1607 for the first time in America administered the Holy Communion. Virginia was a Church of England colony. Various missions were established as the colony grew. The clergy were most of them faithful missionary priests. Some, unfortunately, were men who had bad records at home, and whose lives tended to discredit the Church which they served. In the same year that Jamestown was settled, Prayer Book services were held also on St. George's Island, Maine. Within a short time there were English clergymen settled in Maryland, and before the end of the century, missionaries working in New Hampshire, South Carolina, Delaware, New York, New Jersey and Pennsylvania. In 1692, grants of land were made for Trinity Church, New York. Five years later, the Rev. William Vesey was established as rector of what has become the most important parish in the country.

In New England the Church of England fared badly. The Puritans of Massachusetts Bay had on leaving England professed unalterable attachment to their mother-church. They had, however, adopted a Calvinistic theology differing in various ways from the teaching of the Prayer Book. Shortly after reaching New England, they adopted also the ecclesiastical polity of the Pilgrims of Plymouth. In England, Puritans as well as Anglicans had done their best to suppress «Independents.» Calvinistic Congregationalism became the «standing order» in Massachusetts and Connecticut. The use of the English Prayer Book was made a penal offense and Churchmen, so far as possible, were driven from the colonies. Among the more notable victims of Puritan intolerance were John Checkley, William Blackstone, the Browns of Salem and Samuel Maverick. Some took refuge in Rhode Island, others in colonies farther south.

The 18th century saw increased effort on the part of the Church of England to minister to the needs of colonists in America. Since 1634, colonial churches had been under the supervision of the Bishop of London. In 1696, Bishop Compton of London appointed as his «commissary» for Maryland, Dr. Thomas Bray. Dr. Bray's interest in American missions led to the formation of the Society for Promoting Christian Knowledge (S. P. C. K.) and of the Society for the Propagation of the Gospel in Foreign Parts (S. P. G.). This latter society was especially active in providing missionaries for America, and in furnishing them with means of support. The most notable of these missionaries were the Rev. George Keith and the Rev. John Talbot. They traversed the colonies from New Hampshire to North Carolina and sent to the S. P. G. full reports of the needs of America.

English clergy met with much opposition in New England. There was a special outcry against them owing to secessions from the Congregational ranks. In 1722, the President of Yale College, Dr. Timothy Cutler, and four tutors resigned their positions to embrace Episcopacy. One of these, Dr. Samuel Johnson of Stratford, became the most notable Churchman in Connecticut. One of the wisest and most far-seeing friends of America in England was Dr. George Berkeley, dean of Derry, afterward bishop of Cloyne. He wished to found a training-school for American missionaries. "Saint Paul's College" was to have been situated in — it being a conveniently central point — the Bermuda Islands. Dean Berkeley came to America and spent three years in Rhode Island. He was forced to abandon his project by failure to receive funds which had been promised by the English Parliament.

John and Charles Wesley for a time worked in Georgia in the early days of the colony. This was before any Methodist societies had separated from the English Church. Later Methodist preachers, especially George Whitefield, were vehement in denouncing the Anglican clergy and did much to disturb the S. P. G. missions. However, the work prospered despite draw-backs — greatest of which was the lack of bishops — and by 1775, there were about 300 parishes, ministered to by 250 clergymen. It is estimated that between 1607 and 1775 about 2,000 "Clerks in Holy Orders" of the English Church had, for longer or shorter periods, labored in America.

Organization as an Independent Church.—The outbreak of the War of the Revolution put an end to intercourse between colonial Churchmen and the authorities of the Church of England. Many of the clergy were Tories. These left the colonies for England and Nova Scotia. During the war, services were maintained in a few places, prayers for Congress being substituted for prayers for the King. The one man, whose influence did most to hold together scattered bands of Churchmen was Dr. William White of Christ Church and St. Peter's, Philadelphia. He was in close touch with the fathers of the commonwealth and was for many years chaplain of Congress. Immediately after the recognition of American independence, steps were taken to organize an independent American Church, and to establish new relations with the Church of England, which should recognize "the Change in our Situation from a Daughter- to a Sister-Church."

First to act — for themselves alone — were the clergy of Connecticut. They were convinced that the first step of all must be to obtain bishops. In 1783 a meeting was held at Woodbury, at which a petition was addressed to English bishops to consecrate for America and a candidate was chosen for the episcopal office. The bishop-elect was Dr. Samuel Seabury, a native of Connecticut, an S. P. G. missionary in the colony of New York and recently a chaplain in the British army. He sailed to England and asked for consecration. This he was unable to obtain. The English bishops, as officers of a state-church, were unwilling to act without formal authorization by Parliament. This was not forthcoming. After waiting a year, Seabury, in compliance with instructions from Connecticut, transferred his application to the Episcopal Church of Scotland. The Scottish bishops willingly granted his request and he was consecrated in Aberdeen, 14 Nov. 1784. He signed a "concordate" with his consecrators, in which *inter alia* it was agreed that he should use his influence to introduce in America a Communion Office like the Scottish. This differs from the English one, being, in some ways, "more agreeable to the genuine Standards of Antiquity." Five years later, Bishop Seabury was enabled to keep this promise. His enduring monument is the complete form in the American Prayer Book of the Prayer of Consecration in the Eucharistic Office. Bishop Seabury lived until 1796. He was a noble man and a staunch Churchman. He was indefatigable in administering his diocese, but, partly owing to his "war-record," did not exercise great influence outside of Connecticut. It was not until a century after his death that his fellow-Churchmen fully appreciated the extent of their indebtedness to this first of all bishops in America.

In 1785, delegates from seven colonies south of Connecticut, laymen as well as clergymen, met in Convention in Philadelphia. Their most important acts were to arrange for triennial General Conventions, and to make a new application to the archbishops of England to consecrate bishops for America. There was some delay. The English bishops objected to proposed changes in the Prayer Book. Their objections were met by action of a convention held in Wilmington, Del., in 1786. Finally, on 4 Feb. 1787, English bishops in Lambeth Chapel consecrated Dr. William White to be bishop of Pennsylvania and Dr. Samuel Provoost to be bishop of New York. Four years later, Dr. James Madison, President of William and Mary College, was consecrated in England, bishop of Virginia. The four American bishops in 1792 joined in the consecration of Thomas John Claggett, as bishop of Maryland, through whom the joint succession from the bishops of England and Scotland has passed to every member of the American episcopate.

The bishops of the Church are its chief officers, but the "Constitution and Canons" adopted in 1789, provide that presbyters and laymen shall share their responsibility of administration. Each diocese has a Standing Committee, consisting of presbyters and laymen (in three dioceses, of clergy only) elected by the diocesan convention. This committee acts as a cabinet to the bishop. In case of vacancy in the episcopate, or sometimes during a bishop's absence or incapacity, the Standing Committee for canonical purposes becomes the "Ecclesiastical Authority" for the diocese.

Similarly, the House of Bishops is associated with a House of Deputies in General Convention. The lower House is composed of four clerical and four lay delegates (communicants) from each diocese and one clerical and one lay delegate from each missionary jurisdiction. Either House may originate legislation, but concurrent action is necessary to make it valid. The House of Bishops has a veto on the action of the lower House. All bishops are equal in rank. The senior by consecration acts as primate or "Presiding Bishop." All general disciplinary regulations are comprised in the Constitution and Canons of the General Convention. In addition to these, each diocese has its own Constitution and Canons.

A General Convention was held in 1789. Bishop Provoost and some delegates objected to the recognition of Bishop Seabury, but the objection was overcome by the influence of Bishop White. As Bishop Provoost was absent, Bishop Seabury and Bishop White constituted the first House of Bishops. Their chief work was the revision of the Prayer Book. All proposed changes emanated from the bishops and, with one exception, were ratified by the House of Deputies. The two bishops formed an effective combination. To quote an apt comment of Bishop John Williams: "For the results of that memorable Convention, in which so much was gained — may we not say so little lost? — we are indebted under the over-ruling wisdom of the Holy Spirit to the steadfast gentleness of Bishop White and the gentle steadfastness of Bishop Seabury."

The Prayer Book adopted in 1789 (to which a few additional offices were later added) continued in use for over a century. In 1892 a second revision was completed when the Prayer Book was given its present form. This Prayer Book, which contains all the public offices of the Church, is the best evidence of the doctrinal and ecclesiastical position of the Protestant Episcopal Church. Canons give regulations for practical administration, discipline and clerical education. They give a fair idea of the Church's methods of working. The Prayer Book alone can suggest the faith and spirit which constitute her life.

History during the 19th Century.— For 50 years the Episcopal Church was a small body. It could do little more than assert its right to exist in the face of hostile prejudice. It was suspected for its English antecedents and disliked for its assertion — distinct though timid — of ancient ecclesiastical principles in the midst of prevalent Protestantism. It was perforce apologetically apostolic. It was inevitable, however, that it should gain a firm footing in American life, when its representatives were such clergy as its first bishops and such laity as Washington, Jefferson, Hamilton, Franklin and two thirds of the signers of the Declaration of Independence. For 50 years the most conspicuous figure in the Church was that of Bishop White. His episcopate (1787–1836) was the most important the Church has seen. His wise and gentle guidance of his own people, his fairness and charity toward all others, did much to protect the Church in the critical period of its history.

There were other strong men in the House of Bishops. John Henry Hobart of New York (1775–1830) had the most forcible personality. He was, as his epitaph states, "the able and intrepid Champion of the Church of God." He was enthusiastically loyal to the principles of his Church and saw no wisdom or charity in hesitating to avow them. "Evangelical Truth and Apostolic Order" was his motto. No Churchman of his time did so much to make explicit the principles of Anglican Catholicism.

Alexander Viets Griswold (1766–1843) of the Eastern Diocese (all New England except Connecticut) was influential in a different way. He possessed New England virtues, a serious piety, patient hardihood and frugality, and a great capacity for hard work. His faithful ministrations in all parts of his immense diocese did much to dispel Puritan superstition concerning Episcopacy and the episcopal order.

Philander Chase of New Hampshire (1775–1852), first bishop of Ohio, and later of Illinois, labored indefatigably as a missionary in many States. He was founder of Kenyon College and Bexley Hall, Gambier, Ohio, and Jubilee College, Peoria, Ill. For both of these he obtained funds in England. He was of an eccentric character, but a man of determination. His one aim was to spread the knowledge of his own two treasures, the Bible and the Prayer Book. These men were typical American Churchmen of the first half of the 19th century. Their work indicates very fairly the kind of work done by their fellow-Churchmen in all parts of the country.

Parties.— The work of the Church has been largely missionary; its clergy, men of affairs rather than theologians. It has produced no peculiar school of thought, but has reflected the theological developments of England and Germany. There have been, generally speaking, three types of Churchmen, known respectively as High Church, Low Church and Broad Church. Each of these has emphasized some one side of Church teaching and has not escaped the dangers of one-sided partisanship.

The Low Church represented the 18th century revival in the Church of England which took the form of Evangelicalism within the Church and Methodism without. The truths which it emphasized were the absolute dependence of the spiritual life on the person of Christ, the need of conversion, the reality of grace and purely instrumental character of "ordinances." The Atonement was the central fact in Evangelical theology. (Men of this school were also noted for promoting the cause of foreign missions.) The Evangelicals were dominant until the middle of the 19th century. They were strenuous in opposing High Church teaching as being thinly disguised "Popery."

High Church principles were brought to the fore by the Tractarian (Oxford) Movement which began in 1833. These were the assertion of the character of the Church as a divine society, the special sphere of the working of the Holy Spirit; of the character of sacraments as veritable means of grace; of the central place in Christian worship of the Holy Eucharist. Among the more obvious results of this movement were increased reverence and beauty in church services, increased parochial activity, especially among the poor; the revival of frequent Eucharists and (to some extent) of auricular confession. The later stages of the movement produced a party of Ritualists. They differed from the early Tractarians. Their ritual was largely in imitation of the Latin rite, whereas their predecessors copied a Laudian model; their ideals were mediæval rather than patristic. The early Tractarians sought to revive the teaching and spirit of the first four centuries, the ritualists to reproduce the picturesque externals of the 14th. Both sections of the party emphasized the «sacramental principle» in Christianity and made the Incarnation rather than the Atonement the central fact in their theology.

Parallel with the Oxford Movement was the development of what is variously described as the Liberal Theology or Latitudinarianism. The Broad Church platform is based on the fundamental truth of the Fatherhood of God. It is well described in words of its most distinguished American representative, Phillips Brooks. «The broader theology, which had its masters in England in such men as Dr. Arnold and the Rev. Frederick D. Maurice, has likewise had its clear and powerful effect upon the Episcopal Church. A lofty belief in man's spiritual possibilities, a large hope for man's eternal destinies, a desire for the careful and critical study of the Bible, and an earnest insistence on the comprehensive character of the Church of Christ — these are the characteristics of much of the most zealous pulpit teaching and parish life in these later days.» Broad Churchmen desire to vindicate the rational character of Christianity, to develop its philosophic side, to bring formal statements of the faith into accord with modern knowledge and modern thought. They find themselves much in sympathy with the early theology of Alexandria and more or less opposed to the type of mind represented by Augustine.

There has been conflict between representatives of these several schools, not concerning positive principles but concerning their respective negations. Too often zeal for a half-truth has denied or disparaged another half-truth. In retrospect it seems easy to see that the special principles of the three schools are equally part of the Church's teaching. The difference between them is largely one of emphasis. They divide the Creed between them. The Church Catechism contains a question, «What dost thou chiefly learn by these articles of thy belief?» The answer is: «First, I learn to believe in God the Father, who hath made me and all the world; secondly, in God the Son, who hath redeemed me and all mankind; thirdly, in God the Holy Ghost, who sanctifieth me and all the people of God.» This suggests a generalization which may characterize High, Low, and Broad Church. Each has emphasized one section of the Creed, and, at times, failed to do justice to the others. The Broad Church are concerned for the Fatherhood of God, the moral and philosophical basis of Christian truth. The Low Church are chiefly concerned to present Christ as Redeemer and the Centre of all their thought. The High Church have had to emphasize a neglected portion of the Creed, belief in the Holy Ghost, the Sanctifier, in Church and Sacraments as ordained means of union with Christ. The best men of the various schools have never been mere partisans. Party-lines are now less clearly defined. The tendency is to combine truths, to cultivate an all-round Churchmanship, which has more than one dimension.

Controversy.— For over 30 years, Churchmen were more or less disturbed by discussions aroused by the Tractarian Movement. American Low Churchmen were strongly opposed to the «Oxford Divinity.» The first important incident in the agitation was the «Carey ordination» in 1842. Arthur Carey, a graduate of the General Theological Seminary, who had accepted Tractarian principles, was, in consequence, subjected to a severe examination by the chaplains of the bishop of New York. They declined to recommend him for orders. The bishop, Dr. B. T. Onderdonk, himself examined the candidate, was satisfied with his answers, and proceeded to his ordination. This occasioned an outcry against the bishop, and was the signal for a series of disputes and campaigns of pamphlet warfare, in various parts of the country. In many instances, Low Church bishops objected to the liking of High Church clergy for «awkward chancel-arrangements» suggestive of High Eucharistic doctrine. Bishop McIlvaine of Ohio refused to consecrate a church until the altar was removed from the east wall. Bishop Eastburn of Massachusetts refused to visit a Boston church for confirmations because the clergy kneeled facing the altar, which was surmounted by a cross and candlesticks. These were typical examples. There were discussions over vested choirs, preaching in surplice, stained-glass windows, flowers on the altar, and similar details. There was also an effort made by Low Church partisans to discredit High Church doctrine by impugning the moral character of its leading champions. Partisan motives mingled with the laudable feeling that a bishop like the wife of Cæsar «must be above suspicion.»

A revival of controversy followed the Civil War. At two successive General Conventions, 1868 and 1871, the main discussion concerned a «Canon of Ritual.» Various proposals were made to forbid the use of ceremonies recently revived, and behind this was opposition to Tractarian teaching on the sacraments. In the convention of 1871, Dr. James De Koven of Racine College took a firm stand as champion of «the Real Presence» and challenged anyone to bring him to trial for erroneous doctrine. The challenge was not accepted. In 1875, however, because of his principles, the Church at large refused to confirm Dr. De Koven's election to the see of Illinois, as it had previously refused to confirm the election of Dean George F. Seymour. The Convention of 1874 passed a canon forbidding «ceremonies or practices not ordained or authorized in the Book of Common Prayer and setting forth or symbolizing erroneous or doubtful doctrines.» The accompanying discussion indicates that the framers had especially in mind «the doctrine commonly known as Transubstantiation.» In 1878, Dr. G. F. Seymour was elected bishop of Springfield. This time his election to the episcopate was confirmed by the Church. The event of his consecration marks the end of the effort to deny that High Church doctrine is in harmony with Anglican formularies. It marks also the end of a crusade against ritual as such, although the Church has consistently disapproved any attempt to supersede Anglican by Roman doctrine.

At the time of this later discussion occurred the secession of the «Reformed Episcopalians.» The occasion of this was a controversy over

Baptismal Regeneration. A number of Churchmen who held Zwinglian views of sacraments objected to the wording of the baptismal office. They found a leader in the assistant bishop of Kentucky, Dr. G. D. Cummins. He issued a call for a conference of all who wished to reform the Church. The convention adopted an expurgated Prayer Book and organized as a new sect. Bishop Cummins was deposed by the House of Bishops. He continued, however, to act as bishop and consecrated as a colleague, the Rev. C. E. Cheney, a deposed clergyman of the diocese of Illinois. Their following was never large and has now dwindled to insignificant proportions.

The Church of the Confederacy.— It is pleasant to turn to a striking episode in the Church's history where an unavoidable division was quickly and quietly healed. By the outbreak of the Civil War, Southern Churchmen were isolated from their Northern brethren. Their position was analogous to that of colonial Churchmen at the Revolution. There was this great difference that there were eleven organized dioceses, each with a bishop. These eleven dioceses eventually united to form the Protestant Episcopal Church of the Confederate States. For five years the Church of the Confederacy pursued its independent course. Bishop Polk of Louisiana, who had had a West Point education, assumed command of a Confederate army and was killed in battle. At the end of the War the Church was confronted with the difficult question of the relation of these severed parts. Some Northerners were anxious to take action which would have been very offensive to Southern susceptibilities. There were two specially difficult points, the precedent established by Bishop Polk and the case of Bishop Wilmer of Alabama, who had been consecrated during the War, without the consent of the Northern dioceses. Fortunately the wisdom of a few leaders, Hopkins of Vermont, Horatio Potter of New York, and others, guided all to a satisfactory conclusion. The Convention of 1862 had ignored the absence of Southern delegates. In 1865, the Southern bishops were urged to attend and «trust to the love and honor of their brethren.» Two bishops and delegates from three dioceses responded. In the Convention of 1868, the South was fully represented. By exercise of tact and patience on both sides, Churchmen had succeeded in ignoring «the late unpleasantness.»

Christian Unity.— As has been already noted, the Episcopal Church believes that she has a special mission to promote Church Unity. For 50 years there has been a standing Commission to consider this subject. The occasion of its appointment was the presentation at the Convention of 1853 of a «Memorial» signed by Dr. W. A. Muhlenberg and other well-known clergymen. This «Memorial» made a plea for greater liturgical freedom and a less stringency in conferring Holy Orders. It aimed at taking «an important step towards the effecting of a Church unity in the Protestant Christendom of our land.» The first report of the Commission made valuable suggestions, but led to no immediate results. Important members of the Commission were Bishops George Burgess of Maine and Alonzo Potter of Pennsylvania. The discussion which ensued paved the way for subsequent Prayer Book revision and conferences with representatives of other Christan bodies. Part of the aim of the «Memorial» was realized in 1898 by the passage of the «Huntington Amendment.» This relaxes the obligation always to use the Prayer Book in public worship and recognizes the duty of bishops to provide special forms of service for special congregations and special occasions. Both «Memorial» and «Amendment» aim at making the Church freer for evangelistic work.

There is another side to this work for unity. Dr. Muhlenberg had in mind «the Protestant Christendom of our land.» There is a larger Christendom than this which the Church may not forget. Something has been done to establish friendly relations with Eastern Orthodox and Old Catholics. Bishop Horatio Southgate in 1843 was accredited, as representing the Church, to the Patriarch of Constantinople; Dr. J. F. Young of New York (later bishop of Florida) in 1864, and Bishop Grafton of Fond du Lac, in 1903, have paid official visits to the Church in Russia. Bishop Whittingham of Maryland in 1872 attended the Old Catholic Conference in Cologne. Russian and Old Catholic bishops have on several occasions accepted the official courtesies of the American Church. Polish Old Catholics in America have made definite proposals of union. Another century may see some result from these small beginnings.

Missions.— The Episcopal Church has always been breaking ground in new fields. Her first duty was to extend her work in the Western States. Among the typical examples of the home missionaries were the Rt. Rev. Jackson Kemper, missionary bishop of the Northwest, and Dr. James Lloyd Breck. Dr. Breck with two friends founded Nashotah House in Wisconsin, as a training school for missionaries. Later he removed to Minnesota, organized work among Indians at Crow Wing, and laid foundations for Church institutions in Faribault. Bishop H. B. Whipple developed and completed his work. Still later Breck organized the «Associate Mission for the Pacific Coast.» His last work was the founding of schools in Benicia, Cal. The first bishops in the Pacific States were William Ingraham Kip of California and Thomas Fielding Scott of Oregon and Washington. Most of the Western States contain one or more organized dioceses. There are still 16 missionary jurisdictions in the United States and four others in American possessions. Bishops have been recently sent to Alaska, Sandwich Islands, the Philippines, and Porto Rico.

There are six foreign missionary jurisdictions, Western Africa (Cape Palmas), Shanghai and Hankow in China, Tokyo and Kioto in Japan, and Cuba. Bishops have also been consecrated for independent churches in Haiti, Mexico, and Brazil. The direction of missionary work is entrusted to a Board of Missions with headquarters in New York. Contributions for missions of all kinds probably amount to a million dollars a year.

Institutions.— There are a number of Episcopalian theological schools. The General Theological Seminary in New York is a training school for the whole Church. It was founded in 1817, was removed for a time to New Haven, returned in 1820 to New York, and was shortly after established in Chelsea Square. It owes its present buildings to generous gifts of Dean Eugene Augustus Hoffman. Of other seminaries, the more important are the Episcopal Theological School, Cambridge, Mass., Berkeley Divinity School, Middletown, Conn., the Divinity School of Philadelphia, Seabury Divinity School in Faribault, and Nashotah House.

Trinity College, Hartford, Conn., Kenyon College, Gambier, Ohio, Hobart College, Geneva, N. Y., the University of the South, Sewanee, Tenn., and St. Stephen's College, Annandale, N. Y., are all Episcopalian institutions. Columbia University, New York, always has a Churchman for President and uses Church prayers in its chapel. Lehigh University, South Bethlehem, Pa., is by direction of its founder under Church auspices. There are many diocesan schools for boys and girls and special schools for negroes and Indians. Of the larger Church schools for boys may be mentioned St. Paul's School, Concord, N. H., Groton School, Groton, Mass., and Racine College, in Wisconsin. Churchmen have always been active in promoting charitable work. St. Luke's Hospital, New York, is a conspicuous example of their zeal. There are numerous organizations for the furthering of Church work and a number of religious orders for men and women.

The number of Churchmen is not large, but the rate of increase has been comparatively rapid. In 1800 there were 11 dioceses served by 7 bishops and 208 other clergy; in 1900, there were 86 dioceses served by 80 bishops and about 5,400 other clergy. The number of communicants was about 700,000, a number which implies about 3,000,000 adherents. The total number of clergy to the present time has been more than 9,000, of whom 221 became bishops.

The materials for the history of the Protestant Episcopal Church are to be found in Journals of the General Convention, the memoirs of distinguished Churchmen, and collections of pamphlets in the libraries of Church institutions. Perry's 'History of the American Episcopal Church,' a collection of monographs, is the most complete formal history. There are smaller works by the Rt. Rev. Leighton Coleman, D.D., bishop of Delaware, the Rev. C. H. Tiffany, D.D., and the Rev. S. D. McConnell, D.D.

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Protestantenverein, prō-tĕs-tăn-ten-fĕ-rīn' (Protestant Association), a society founded at Frankfort on the Main in 1863 for the promotion of liberalism in the Protestant state churches of Germany. Its originators were notable clergymen, publicists and university professors. In 1863 the jealousies between Calvinists and Lutherans still persisted, though Calvinism and Lutheranism had 45 years previously been ostensibly reconciled in the constitution of the Prussian Evangelical Church. In all the Protestant state churches of Germany the authority of the prince, his ministers, or the clergy was supreme: the Protestantenverein demanded lay representation in the parochial and synodal administration of church affairs; further, they demanded the federation of the separate established churches in one national church. The Protestant churches were obscurantist, creed-bound, and hostile to all free inquiry in matters affecting religious belief: the Protestantenverein held that «the attempt to limit the freedom of theological inquiry is a violation of the vital principle of Protestantism.» And the association announced as one of its principal aims to arouse popular sentiment in Germany against the encroachments of clericalism and hierarchism in the Protestant churches and against the pretensions of the Papacy. The union was from the first viewed with jealousy by the governments and by the conservative majority in the several churches; and though before the law its members were under no disability, still, whether clergymen or university men, they found themselves effectually barred from pulpits and chairs in the seats of learning, or from advancement. All Germans who are Protestants and who are willing to promote the objects of the association are eligible to membership. Besides the general Protestantenverein, comprising its membership in all the German states, there are particular unions, one for northwestern Germany, one for Baden, one for Silesia, and so on. The meetings of the general body are biennial, those of the several states, annual. The May Laws or Falk Laws, designed to root out Roman Catholicity, and the reorganization of the Prussian state church in 1879, were fruits of the agitation carried on by the Protestantenverein. But after a few years political opportunism dictated to the government the policy of repealing the Falk Laws; and when, under the new system of lay representation in the church's councils, members of the general synod of the Prussian national church were to be chosen, only nine members of the Protestantenverein were elected, to 70 representatives of the most conservative orthodoxy. In 1880, the Protestantenverein had 26,000 members in 80 local associations.

Protestantism, the religious system and profession of Protestants. *The Name.*— Like most political and religious party designations, the name «Protestantism» was accidental in its origin and very inadequately expresses the nature of what it labels. In 1529 an edict of the Diet of Spires threatened the German Reformation with extinction. Five princes and 14 cities made formal protest against the validity of the edict and were jointly known as the protesting Estates, or Protestants. The name soon came to designate all who sided with the Reformation in Germany, and is now the common name of all Christian bodies in the West which refuse obedience to the Roman Catholic Church. The name has been unsatisfactory to many, especially in the Anglican and Lutheran Churches, because it is merely negative and polemical and does not do justice to the positive, evangelical character of Protestant Christianity. On the other hand it may be said that Protestantism had its historic origin in opposition to Roman Catholicism and that its nature and principles can be fully understood only when they are viewed in that contrast, so that the name has a measure of justification.

The Historic Roots of Protestantism.— Contrary to the popular conception, the roots of Protestantism run back far beyond Martin

Luther. Its conscious life began with him. His powerful personality impressed itself on the movement. But he alone would be quite inadequate to explain it.

The age before the Reformation was a revolutionary age. The Holy Roman Empire was waning; the modern state was taking shape. The economic and social order was profoundly unsettled by the progress of capitalistic industry and commerce. The revival of learning had created new intellectual tastes and interests; scholasticism, a theology and philosophy reverend with age, was put aside by younger minds as insipid and barbaric. The invention of printing made intercourse of mind with mind easy and education a common possession.

Amid so vast and general an upheaval it was impossible for the institutions of mediæval religion, which were so deeply intertwined with all the life of society, to remain unaffected. "Reform of the Church in head and members" was earnestly called for by many of the most eminent religious leaders of the century preceding the Reformation. In the great Reform Councils of the 15th century; in the national movements in England and Bohemia, which were led by Wyclif and Huss; in the efforts of the Franciscans and of the Waldenses and Cathari to restore the primitive simplicity of the Christian life; in the ridicule of poets and the doubt of theologians we trace a swelling tide of reformatory sentiment. There was an abundance of noble spiritual and moral life among the people and clergy; the incessant protests against the existing abuses are the most eloquent testimony to the moral vigor which was itself a product of mediæval religion. But evil is always slow to yield. What seemed intolerable exploitation and oppression to the mass of the people, was an indispensable source of income and a time-honored and lawful custom to powerful individuals and classes. Efforts for reform were again and again frustrated, and so the final explosion of the pent-up forces is historically comprehensible. Without this accumulated dissatisfaction of generations, Luther would have cried to deaf ears. Protestantism can be understood only against this background. It was not at the outset a demand for a change of doctrine, but a practical reformatory movement.

The First Rapid Spread of Protestantism.— On Hallowe'en of 1517 Luther posted his 95 Theses on Indulgences. They were a halting and uncertain protest against a practice which was endangering the spiritual integrity of the people. He expected to debate his theses with some university professor; instead of that Europe took up the debate. Within a fortnight those 95 sentences had echoed through Germany; within a month through Europe. The popular response gave Luther daring. From 1519 to 1523 he was the voice of a nation aroused and angry. His manifesto 'To the Christian Nobility of the German Nation' was a terrific enumeration of the social, political, and religious grievances of Germany. His 'Prelude on the Babylonian Captivity of the Christian Church' attacked those doctrines and practices of the Church which clustered about the seven sacraments. The Pope excommunicated him; Luther burned the Bull. The Diet of Worms demanded that he recant; he refused. The favor of his prince and various international complications combined to defend him. But back of all stood the protecting public sentiment of the nation.

In these earlier years of the Reformation the purpose was not to create a new Church, but to reform the one Church. As fast as the reformatory ideas spread and the resistance of civil and ecclesiastical authorities could be overcome, evangelical preaching was introduced. Almost simultaneously with the movement centring at Wittenberg, the Reformation had found a second focus in German Switzerland under the leadership of Zwingli. About 1525 a third and still more radical reformatory movement began to run through the lower classes of Germany, persecuted by all parties alike under the name of Anabaptism; a movement, the extent and religious power of which are only now coming to be appreciated. From 1536 onward Geneva under the leadership of Calvin's systematizing and organizing genius became the great spiritual centre of Protestantism for Switzerland, France, the Netherlands, Scotland and England. These rapid and almost simultaneous movements show that the Reformation was not an artificial contrivance of a few insurrectionary spirits, but the outcome of a great popular feeling and desire. But that the reformatory uprising finally ended in a permanent schism of the Church was not an absolutely necessary outcome of the situation. A less violent spirit on the part of the reform elements and less reluctance to grant the inevitable reforms on the part of the hierarchy before it was too late, might conceivably have averted that result. Historians will differ as to the apportionment of guilt.

For about half a century Protestantism on the whole advanced victoriously. It encountered the natural instinct of conservatism, the resistance of all classes that were interested in existing conditions, and the opposition of most governments, but it was not yet face to face with the full enthusiasm of religious conviction. At the end of 50 years it was firmly intrenched in Saxony, Hesse, Würtemberg and the Palatinate; in the most important cantons of Switzerland; in the northern Netherlands; in Denmark, Sweden, Prussia and Livonia. In another group of countries the issue was still in doubt. In France the Huguenots were an intelligent and powerful minority, able to wage wars and make treaties with the Crown. The Flemish Netherlands for a time went with the Dutch in revolt against Spanish and Roman Catholic domination, until the Treaty of Arras in 1579 cut them loose. In Bavaria, Poland and Hungary the people were largely Protestant and almost in control of the situation. In the Grand Duchy of Austria it is said that only a thirtieth part of the people remained faithful to the old Church. If the choice of religion had been left entirely to the common people, it is probable that most of the continent of Europe north of the Alps and Pyrenees and west of Russia would have become Protestant. In the British Islands the Reformation began in earnest with the return of Knox to Scotland in 1559 and the reign of Edward VI. in England (1547–53), and was destined to succeed. Ireland remained untouched by it. In Italy and Spain reformatory leanings remained confined to groups of educated people. The Reformation did not find the support of governments, nor did it have time to become a popular movement. The Inquisition, reorganized in Italy by Caraffa, 1542, put an effective end to any movement that might have grown up. It is often assumed that only the Teutonic nations have a natural affinity for the Protestant type of Christianity, because the Latin nations failed to embrace it in the 16th century. But their failure to do so was hardly due to natural predilections. The theory can not be said to have had a fair test at that time.

The Roman Catholic Reaction Against Protestantism.— In the middle of the 16th century the tide turned on the continent of Europe. Those countries in which the issue had remained in doubt, were wrested from the grasp of Protestantism and restored to the Catholic Church, and no further important territorial gain was made. This remarkable change was largely due to the rallying of the spiritual forces of Catholicism on the one side, and to the weakening of the spiritual forces of Protestantism on the other.

Many eminent men who remained loyal to the Roman Church and held its doctrines to be infallible and irreformable, had yet recognized the justice of many of the complaints about practical abuses, and hoped by reform of the Church from within to conciliate the Protestants and if possible heal the schism. This party was now overborne by another which also desired reform, but at the same time advocated uncompromising insistence on the sole authority of the Roman Church. The Council of Trent (1545–63) gave an authoritative definition of those doctrines which had been assailed by Protestantism and henceforth there could be no doubt what the Catholic faith was. A new monasticism arose, of which the Jesuit Order was the finest type, which flung itself with splendid zeal into the service of the needy, the conversion of the heathen, and the conflict with heresy. Protestant leaders had made a powerful appeal to the intellect through preaching and writing. The Jesuits met them on their own ground. The combination of Protestantism with Humanism had made the Protestant schools the attractive seats of learning. The Jesuits now took higher education under their care and especially succeeded in molding the young men of the upper classes. The people were urged to a more frequent use of the confessional and this furnished an effective means of counteracting Protestant leanings wherever they came to light in the thought of a penitent. Its peril had not been without effect on the Church. Abuses which had long been the sorrow of its earnest men were stopped. With Paul IV. a succession of popes began, very different from those of the previous century, and as earnest and austere as some of the greatest popes of the Middle Ages.

Under such leadership and with such renewed self-assurance and enthusiasm the Catholic Church of the second half of the 16th century was a far more formidable adversary than Protestantism had hitherto found it. To this was added the immense political power still left to it, which it now used with a new determination and unity of purpose. If the majority of any people were Protestants and the rulers of a nation were Catholic, force lay with the latter and that prevailed. Protestant historians hold that if the conflict had been intellectual and spiritual only, the outcome would have been different.

While Roman Catholicism had rallied its forces the spiritual force of Protestantism had declined. The first group of heroic leaders was thinning in numbers, and its successors were not equal to them. The athletic vigor and joy of a newly found faith had waned. The contest for great truths often degenerated into a wrangle over points of doctrine. Protestantism was split into two camps, the Lutheran and Reformed, and these spent some of their strength against each other. The Religious Peace of Augsburg in 1555 had granted religious autonomy to the Lutheran estates of Germany. From this assured position they could look on with indifference while Calvinistic Protestantism was fighting for its life in France and Holland. Protestantism lacked the international organization and centralized direction of Roman Catholicism. Popular sympathy for the persecuted brethren abroad was ineffective unless the political interests of the princes happened to work in the same direction. It had no such mobile corps of soldiers as the religious orders supplied to Roman Catholicism. The strength of Protestantism lies in its appeal to individual conviction and its capacity to set free the initiative of the individual. But in Lutheran countries ecclesiastical government was vested in the princes and the theologians and not at all in the people. In the Calvinistic churches there was more popular participation, and this resulted in stricter church discipline, sterner morality, and immense tenacity and power of resistance. But even they did not fully evoke the power of devotion, of sacrifice and moral vigor latent in the plain people whose spontaneous cooperation would have made the Protestant nations invincible.

From the middle of the 16th century for a hundred years the conflict between Roman Catholicism and Protestantism forms the substance of European history. This duel found its outward expression in the great "wars of religion." In France the Huguenot wars ran with intervals from 1562 to 1598 and ended with the Edict of Nantes, which recognized the civil equality of Protestants, but conceded only a limited right of worship. The war between Roman Catholic Spain and the Netherlands extended with intervals from 1568 to 1648 and the Thirty Years' war in Germany from 1618 to 1648. When the wars closed, Protestantism had lost the debatable ground: France, Belgium, Bavaria, Austria, Bohemia, Poland. But it was not beaten out of the field; it held Scandinavia, northern Germany, the Dutch Republic, the Protestant cantons of Switzerland, Scotland and England. And now the religious impulse and enthusiasm of Roman Catholicism in turn had spent themselves, just as the first aggressiveness of Protestantism had formerly ebbed. The ancient jealousy between the House of Hapsburg and France once more proved stronger than the religious interest. Protestant Germany was saved in the Thirty Years' war by the alliance of Gustavus Adolphus, the champion of Protestantism, and Richelieu, the head of Roman Catholic France. Europe stopped in sheer exhaustion, and in the Peace of Westphalia, 24 Oct. 1648, the old and new faiths agreed to tolerate each other and live side by side. The ancient conception of the outward unity of the Church and of the necessary uniformity of worship within each nation, was surrendered. Henceforth the religious life of the Western world was to run in two channels, but not without profound influence of each on the other.

Protestantism in Great Britain.— England, in its comparative isolation from the rest of Europe, ran a course of its own. Its real Reformation only began when the wars of religion closed on the Continent. The English Reformation, indeed, was not, at first, a great popular movement, and consequently lacked such leaders as are born in the travail of a whole nation. The repudiation of papal supremacy under Henry VIII. (1531) was scarcely due to reformatory leanings. Under Edward VI. (1547–53) the ideas of the Reformation began to make real progress, but they were still promoted from above and encountered the resistance of the people. The persecutions under Mary (1553–8) first kindled that hatred of popery which became part of English traditions. Under Elizabeth (1558–1603) England was slowly and moderately Protestantized. By natural tastes the queen did not lean to innovations, but the denial of her legitimacy and her right to the throne by Pope Paul IV. allied her self-interest with what Protestant convictions she had. The country followed her. Of 9,400 Roman Catholic priests only 189 refused the oath of supremacy. By 1570 the influence of the Roman Catholic Reaction began to make itself felt in England. Priests of the new zeal came to England as emissaries. English Protestants saw their brethren on the Continent crushed, their own country threatened by Spain under Philip II., the life of their queen in constant danger. A fearful spiritual tension was created. A bull of Pius V. deposed Elizabeth and forbade Englishmen under penalty of excommunication to obey her. When an English monarch demanded the oath of allegiance from English subjects, Paul V. forbade them to take it under the same penalty. This identified Roman Catholicism with treason and forced Roman Catholics into a terrible dilemma. The severe persecutions endured by them were at least ostensibly directed against their treason, and not against their religious belief.

The Reformation in England had wrought its changes with great moderation. The Thirty-Nine Articles embody the Calvinistic theology prevalent at the time of their adoption (1563 and 1571), but the hierarchical organization of the clergy inherited from Roman Catholicism had been retained, and the forms of worship modified with a gentle hand. During the 17th century a more strenuous Protestantism gained ground. English Calvinism became Puritanism. A thorough purging of the doctrine, constitution and worship of the Church was demanded. The Presbyterian party sought to conform the Church of England to the Scottish and other Calvinistic churches. The Independents were still more radical. They were opposed to established churches, held that each congregation should have the right to govern itself, and favored a large measure of religious liberty. Radicalism in religion linked itself quite naturally with a corresponding democracy in civil affairs. During the Civil War and the Commonwealth (1649–60) control passed successively to the more radical parties. The reform outran the sentiment of the nation. An inevitable reaction followed. But though Puritanism failed outwardly, it had transformed England. Since the Commonwealth, England has had a Protestant soul. The efforts of James II. to introduce Roman Catholicism once more ended in the Revolution of 1688. A century later the Roman Catholics of England numbered only about 65,000. The bold Protestantism of the Independents of the Commonwealth was too far ahead of its time to stand, but it was prophetic of the future. The political and social ideals of that uprising have slowly been realized during the last 250 years, and the development of church and religion has tended in the same direction.

Later History of Protestantism.— Since 1648 there has been no serious change in the territorial base of Protestantism and Roman Catholicism in Europe. Each has held what it then had. In Italy, Spain, Portugal and Belgium the number of Protestants is very slight. On the other hand, in Denmark, Sweden and Norway Roman Catholics number only a few thousands. In spite of the decimation suffered by Protestants in France after the Revocation of the Edict of Nantes (1685), they have again grown considerably in numbers and are important through their intellectual and moral influence. In Austria they numbered in 1900 about 494,000 or 1.9 per cent of the population, and in Hungary 3,703,888 or 19.4 per cent. Of recent years there has risen in Austria a mass movement away from Roman Catholicism, the *Los-von-Rom Bewegung,* the final importance of which can not yet be foreseen. Switzerland in 1900 had 1,918,197 Protestants and 1,383,135 Roman Catholics. Germany had 35,231,104 Protestants and 20,327,104 Roman Catholics, and the percentage had scarcely changed from 1880 to 1900. The Netherlands had 1,790,161 Roman Catholics in 1899 in a population of 5,104,137. In Ireland Protestants numbered in 1901 25.8 per cent of the population of 4,458,775. According to the official Roman Catholic statistics of the Congregation *de Propaganda Fide* for 1898 the Roman Catholic population of England and Wales was 1,362,489 out of a population of 32,000,000, and in Scotland 373,500 out of 4,400,000. In 1900, 4 per cent of the marriages in England and 10.24 per cent of those in Scotland were celebrated according to Roman Catholic ritual. The great increase of Roman Catholics in England during the 19th century and in Scotland during recent years, has been due mainly to Irish immigration. The conversions in England have been more important in character than number. The countries of South and Central America are almost wholly Roman Catholic and swell the Roman Catholic total. Canada, in a population of 5,371,315 in 1901, had 3,141,715 Protestants. About 65 per cent of the Roman Catholics are massed in the Province of Quebec. The religious statistics of the census of 1900 for the United States have not yet been published. The official Roman Catholic statistics for 1898 gave the Roman Catholic communicants as 9,479,250, but the term "communicant" is more inclusive in the Roman Catholic Church than in most Protestant bodies. The number of Roman Catholics in the United States has increased immensely during the 19th century, partly through the acquisition of new possessions in the Southwest, but mainly through Roman Catholic immigration from Ireland and

Germany formerly and more recently from Canada, Italy and Austria, and the natural increase of these immigrants.

The Distinctive Characteristics of Protestantism.— Protestantism is not a single organized body. There is no central authority able to define its positions. The various Protestant churches have realized the genius of Protestantism in the most varying stages of clearness. Scarcely anything can be asserted about Protestantism as a whole which would not be contradicted by the history of some Protestant body or of all Protestant bodies at some stage of their existence. Its origins furnish no clear expression of it, for the stream carried away a heavy sediment from the banks among which it rose. Luther, for instance, was in most respects a very mediæval man. Protestantism is a historical movement, a tendency. It has gone through a gradual process of self-purification and has come to clearer consciousness of itself. These qualifications must be borne in mind in considering the following enumeration of the more important characteristics of Protestantism:

1. Protestantism is a simplification of religion. Instead of many external religious performances, it calls for one thing: faith. Faith in that sense is the formula for an attitude of the soul toward God, for the innermost life of loving obedience. That faith justifies, and the externals of religion have value only in so far as they express or strengthen that relation.

2. This simplification of religion involves a simplification of church worship. The Reformation involved a critical scrutiny of the inherited forms of worship and the elimination of all that seemed to the Reformers contrary to the Bible or repugnant to their religious feeling. In their recoil they often went to the other extreme of making worship bare. But even where Protestant worship is most ornate, it is simpler than the liturgical splendor of the Greek or Roman Church.

3. In consequence of the characteristics just mentioned, the visible organization of the Church occupies a smaller space in the spiritual horizon of Protestants than of Greek or Roman Catholics. For Roman Catholics the hierarchy of the Church is the sole channel through which the infallible teaching of Christianity and the saving grace of the sacraments must flow. The relation of the individual to God depends largely on his relation to the Church. For a Protestant his relation to the Church depends on his relation to God. Protestantism sends men to the Bible for truth and to God direct for saving grace. Consequently Protestantism is less essentially churchly. Church attendance is less a true gauge of religious life in Protestant churches.

4. Thorough-going Protestantism recognizes no essential difference between clergy and laity. It holds, at least in theory, to the universal priesthood of believers, that is, to the direct and equal access of every believing soul to God. The clergy have grown less important and laymen have become more important in the worship and government of the Protestant churches.

5. As a consequence of these convictions and in historical reaction against the hierarchical structure of the mediæval church, Protestantism in varying degrees has tended to democratize church government. The Church of England retained the episcopacy inherited from the past. The Calvinistic Churches developed a kind of aristocracy in presbyterial government. The bodies with congregational organization have self-government like that of the New England town-meeting. As an indirect result radical Protestantism has had a marked affinity for civil democracy and has made for popular liberty.

6. Protestantism to-day has accepted the principle of religious liberty and freedom of conscience. In the 16th and 17th centuries it followed inherited theories and was at times more tyrannous over the individual reason and conscience than mediæval Catholicism had been. But the respect for individual conviction has become steadily greater. There is probably no Protestant body to-day that would not repudiate the use of force in punishing heresy or in enforcing religious conformity. By granting liberty and demanding individual conviction, it has powerfully developed the sense of personal worth, the claim of a man to his own mind, and that capacity of initiative which is one of the causes for national efficiency. This has also been a chief cause for the development of science, for freedom is the life-breath of all higher intellectual work.

7. In one aspect Protestantism was an effort to emancipate the human mind and soul from the bondage of inherited doctrines and institutions. It was compelled to challenge and scrutinize the claims of ancient authorities. Consequently it developed the critical conscience. It has given fairly free course to historical science and undergoes a continuous self-purification by it. The Protestant exaltation of the Bible was originally a part of this desire to get beyond all late, and possibly doubtful, authorities, and to find out from the original documents what Christianity reallv means. It was a quest for unadulterated Christianity.

8. Protestantism is comparatively unfettered by its past and therefore free to advance. Protestant bodies make no claim to infallibility in their past beliefs and utterances, and therefore they can change their creed and confess that their past practices were wrong. If, for instance, a Protestant body in a speculative period of theology, has implied in its creed that some babes may be eternally lost, it can eliminate that from its creed, and such an action will be no confession of weakness, but an evidence of growing light. If Calvin secured the burning of Servetus and Melanchthon praised it, their religious descendants can erect an expiatory monument to the memory of the heretic. Thus Protestantism has the same power as the individual, of rising by putting its dead past under foot.

9. Protestantism has abandoned ascetic morality. Throughout the Middle Ages it was held that the perfect life was one of poverty, of abstinence from married life, and of obedience to ecclesiastical superiors, and that he who followed these "counsels of perfection" did more than God required of him and earned merit. Protestantism denies that man can ever do more than God requires, and that ascetic morality is higher at all. It holds that God is best served within the natural human relations.

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estantism.— The general Church Histories of Gieseler, Möhler, Hase, Schaff (Vols. VI. and VII.), Sheldon, and Alzog (Catholic). *On the History of the Reformation:* Fisher, 'History of the Reformation'; Häusser, 'Period of the Reformation'; each in compact form and excellent. D'Aubigné, 'History of the Reformation,' is very widely read, but has strong Protestant bias. Archbishop Spalding, 'History of the Protestant Reformation,' is an equally vigorous Catholic reply to it. Janssen, 'Geschichte des deutschen Volkes,' Vols. II. and III., give a celebrated Catholic account, charged with unfairness. Ranke, 'History of the Reformation in Germany,' 3 vols., is the work of a very great historian. Köstlin and Michelet give good biographies of Luther. Wace and Buchheim, 'First Principles of the Reformation,' gives a translation of three fundamental early writings of Luther. See also bibliography under LUTHER. Seebohm's 'Era of the Protestant Reformation' is a brief and simple account of the times. The English Reformation is described in Green, 'History of the English People'; Froude, 'History of England'; Burnet, 'History of the Reformation'; Blunt, 'Reformation of the Church of England'; Stoughton, 'Ecclesiastical History of England.' The following works, though dealing with special sections of history, all bear on the general struggle of Protestantism and Catholicism: Ranke, 'History of the Popes in the 16th and 17th Centuries,' 3 vols.; Macaulay's famous 'Essay on Ranke'; Robertson, 'Charles V.'; Prescott, 'Philip II.'; Freitag, 'Bilder aus der deutschen Vergangenheit,' Vol. II.; Froude, 'The Council of Trent'; Symonds, 'The Catholic Reaction'; Motley, 'Rise of the Dutch Republic'; 'History of the United Netherlands'; and 'Life and Death of John of Barneveld.'

On the Doctrine and Principle of Protestantism.— Schaff, 'The Creeds of Christendom,' 3 vols., gives in the third volume the most important Protestant creeds, and in the first volume a historical introduction to them. Volume II. gives the Catholic creeds. J. A. Möhler, 'Symbolism, or an Exposition of the Doctrinal Differences between Catholics and Protestants'; and Hase, 'Handbuch der protestantischen Polemik,' are the best polemical handbooks, the one Catholic, the other Protestant. Schenkel, 'Das Wesen des Protestantismus'; Orr, 'The Progress of Dogma'; Schaff, 'Christ and Christianity,' two essays on 'Protestantism and Romanism,' and on 'The Principles of the Reformation'; Kahnis, 'Die Prinzipien des Protestantismus,' are all discussions on the essential principles. I. A. Dorner, 'History of Protestant Theology,' 2 vols., is a solid history of theological thought. Harnack, 'What is Christianity?' in its second part gives a brilliant sketch of Greek and Roman Catholicism and of Protestantism.

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On the Present Status of Protestantism.— The annual issues of 'The Statesman's Year-Book' give statistics and facts on the religion of the various countries of the world. The Census Report for 1900 will give the latest facts about the United States. Carroll, 'The Religious Forces of the United States,' is a thoroughly informed manual. 'Les Œuvres du Protestantisme Français au XIX. Siècle' is a sumptuous illustrated account of present French Protestantism. 'Der Protestantismus am Ende des Neunzehnten Jahrhunderts in Wort und Bild,' 2 vols., edited by C. Werckshagen, is a splendid illustrated account of the history and present power of Protestantism, in 50 essays by very competent scholars.

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Proteus, prō'tūs or prō'tē-ūs, in Greek mythology, according to Homer (whose account is the one chiefly identified with the name, "the old man of the sea"), a subject of Poseidon (the sea god), gifted with the power of prophecy, who pastured the seal herds of Amphitrite upon the shore of the island of Pharos near the mouth of the Nile. He is represented as of great age and able to change himself instantly into any form he might wish. To compel him to prophesy it was necessary to steal craftily upon him and hold him so that he might not escape whatever form he took. Menelaus, as told in the Odyssey, succeeded in doing this even though Proteus became in turn fire and water. Allusions to Proteus refer to his power of assuming many forms, as in the adjective, protean. Herodotus relates that Proteus as king of Egypt entertained Paris and Helen, but giving Paris a phantom in her stead, kept Helen with him and afterward restored her to her husband Menelaus.

Proteus, a remarkable genus of urodele Amphibians allied to the axolotls, sirens, etc., and often called "mud-puppies." The gills in these are retained throughout the entire lifetime of the animals, in addition to the lungs with which they are also latterly provided. These animals are found only in the waters of certain subterranean caves in central and southern Europe. The animal itself is about 12 inches long. Its body is elongated, slender, and somewhat cylindrical, and averages about one inch or three quarters of an inch in diameter. It is of a pale flesh tint — the absence of color being the necessary result of its non-exposure to light. The tail is broad and compressed. The limbs are weak, the front legs possessing three and the hinder limbs only two toes. Three pairs of bright red or scarlet branchiæ or gills project from the branchial clefts on each side of the neck. Two series of small teeth exist in the upper and in the lower jaw. The eyes are rudimentary and completely covered by the skin. The proteus is eminently aquatic in its habits, and in dry seasons, or when the water of the caves becomes dried up, is said to bury itself in the mud. For the development of this group see Embryology.

Proteus Animalcule. See Amœba.

Protevangelium, prō-tē-văn-jĕl'ĭ-ŭm (Gk. «the first gospel»), term applied to the passage in the Old Testament, Genesis iii. 15, in which theologians see the first announcement of the coming of a Messiah.

Prothero, prŏth'ĕr-ō, **George Walter,** English historical writer: b. Wiltshire 14 Oct. 1848. He was educated at Eton, Oxford, and the University of Bonn, was university lecturer in history and tutor of Kings College 1876–94, and professor of history at the University of Edinburgh 1894–9. He is editor of 'The Quarterly Review' and has published 'Life and Times of Simon de Montfort' (1877); 'Memoir of Henry Bradshaw' (1889); 'British History Reader' (1898); etc.

Prothero, Rowland Edmund, English author, brother of G. W. Prothero (q.v.): b. Clifton-on-Teme 6 Sept. 1851. He was educated at Marlborough and Oxford and was editor of 'The Quarterly Review' 1894–9. He is the author of 'Pioneers and Progress of English Farming' (1887); 'Life and Correspondence of Dean Stanley' (1893); and has edited the 'Letters of Edward Gibbon' (1896); 'Letters and Journals of Lord Byron' (1898–1901); etc.

Prothon'otary, in Pennsylvania, and a few other States, the name given the judge of the orphans' court. (See Court, Probate.) Formerly the term was applied to certain functionaries connected with the papal court who receive the last wills of cardinals, make informations and proceedings necessary for the canonization of saints, etc.

Protis'ta, a group-name introduced by Haeckel to include the simplest forms of life, and hence probably the first to appear on the earth. It has failed of general acceptance, and its members are divided between the protozoans and the unicellular plants.

Protoamœba. See Moner.

Pro'tocol, in diplomacy, the minutes or rough draft of an instrument or transaction; the original copy of a treaty, despatch, or other document; a document serving as the preliminary to diplomatic negotiations; a diplomatic document or minute of proceedings, signed by the representatives of friendly powers in order to secure certain political ends peacefully; a convention not subject to the formalities of ratification. By a *protocol* concluded and signed 12 Aug. 1898, by William R. Day, secretary of state of the United States, and Jules Cambon, ambassador extraordinary and plenipotentiary of the republic of France, at Washington, respectively representing for that purpose the government of the United States and the government of Spain, the United States and Spain agreed upon the terms on which negotiations for the establishment of peace between the two countries should be undertaken. Following the signing of this peace protocol, President McKinley issued a proclamation suspending hostilities.

Protogenes, prō-tŏj'ĕ-nēz, Greek painter, contemporary with Apelles: b. Caunus on the borders of Caria. He lived about 350 B.C. He was one of the first of Greek realists in painting. Several masterpieces of his are mentioned, in one of which a hound was represented panting, and with foam on his mouth. Pliny relates that for a long time the painter failed in the execution of the foam; but at last, in a fit of anger, threw against the picture the sponge which he used in painting, and thus accidentally produced a natural representation of it. This picture saved the city of Rhodes when it was besieged by Demetrius Poliorcetes, who refrained from making his attack on the weakest part of the city where the picture was placed. Protogenes is said to have lived in comparative obscurity at Rhodes till the 50th year of his age, when his merits were made known to his fellow-citizens through a visit of Apelles (q.v.). Apelles offered Protogenes an enormous sum for each of his works, which the painter himself had been in the habit of selling for very insignificant sums. The Rhodians now wished to buy back the pictures from Apelles, in order that they might keep them among themselves, but Apelles refused to part with them except for an advance. Protogenes subsequently went to Athens, where he executed one of his finest pictures in the Propylæa. In the time of Cicero it was still in that city, but Vespasian carried it to Rome, and placed it in the Temple of Peace, in which it was burned under Commodus.

Protohip'pus; Protorohippus; genera of early fossil ancestors of the horse. See Horse, Evolution of.

Pro'tophytes. See Fungi.

Pro'toplasm, the elementary or primitive organic compound of an albuminous nature, which enters into the composition of organized tissues of all kinds. The term is more especially used to denote the substance — indistinguishable from the primitive base of the tissues in higher forms — of which the bodies of the lowest animals (*Protozoa*) and plants (*Protophyta*) are wholly composed. But no appreciable difference, either chemical or microscopical, is to be perceived between the protoplasm of these lower forms of life and that out of which the tissues of the highest animals are elaborated. This protoplasm, therefore, enters into the intimate composition and formation of animal and plant tissues of every kind. It forms the indispensable medium, as it were, and at first sight, for the presence and manifestation of vitality. The tissues of the highest plant or animal form may be considered simply as consisting of elaborated protoplasm, equally as the body of the lower animalcule or plant consists of that substance in a more primitive and undifferentiated state.

In its chemical composition protoplasm exhibits carbon, hydrogen, oxygen, and nitrogen united to form one of a group of proximate compounds to which Mulder gave the name of ‘proteine’ compounds. See Anatomy.

Protothe'ria, a division or subclass of mammals including the *Monotremata* and with more less certainty some fossil forms grouped as *Protodonta* and *Multituberculata*. In the living forms their most marked peculiarities are the fact that they have but a single opening for the digestive tract and the urogenital system; and that they are oviparous. The sutures of the skull are obliterated, and while in the young there are peculiar teeth with many tubercles upon the crown, these are lost in the adult, the jaws being furnished with horny plates. Similarities in the teeth lead the fossil forms to be associated here. The only living examples are the duckbill and scaly ant-eaters (*Echidna*). The marsupials are sometimes known as *Metatheria*, and all other mammals as *Eutheria;* but the latter term is more scientifically made to include all mammals except the monotremes. Consult Beddard, ‘Mammalia’ (1901).

Protozo'a, a phylum or branch of the animal kingdom set off from all other branches which together constitute the *Metazoa*, and distinguished by the simplicity of organization. The animal consists of but a single cell or a colony of simple cells. The group manifests gradual transitions at several points from such forms as are distinctively animal organisms to those which are as clearly plants. And on the other hand, certain higher forms show the first stages in differentiation among the cells of the colony which mark the advance to the metazoön organism.

The *Protozoa* manifest a physiological complexity as striking as the structural simplicity, in that all the functions of higher organisms are here discharged by the single cell. In the place of the tissues and organs of the higher animals, one finds differentiations within the single cell which are related to special functions and hence analogous to organs. These are denominated cell-organs, or organellæ, and include locomotor structures such as pseudopodia, flagella and cilia, protective coverings of a permanent character such as shells, shields, or spines, or temporary, as cysts formed at the reproductive period or in times of stress in the environment. Of this type are further the mouth and anal openings with highly modified attachments of various sort relative to the ingestion of food or extrusion of waste, the sucking tubes of the *Suctoria*, the digestive, excretory and contractile vacuoles, the means of attachment developed in parasitic forms, and many other structures similarly connected with special functions.

Some years ago it was held that certain *Protozoa*, the *Monera* of Haeckel, were without any nuclear structures. This view has not been confirmed by later investigations. The simple protozoan is uninuclear; the multinuclear condition is evidence of a colonial organism or of a phase in reproduction. In one group, however, two types of nuclei coexist, and are known as the sexual and the somatic nucleus, or micronucleus and macronucleus.

Simple or multiple division is the ordinary type of reproduction and occurs either in the free or in the encysted condition. Two types of reproduction may alternate in the life cycle of a given form and so-called sexual processes have recently been demonstrated in various groups. In these there occurs the fusion of similar individuals (isogametes) or of dissimilar (macro- and microgametes), or a temporary union (conjugation) of two individuals, accompanied by an exchange of nuclear matter. There exists a close parallel between these phenomena and those of maturation and fertilization in the metazoan egg-cell.

The phylum consists of four well defined classes, namely: (1) *Sarcodina*, with the subclasses *Rhizopoda*, *Heliozoa*, *Radiolaria*, and *Mycetozoa;* (2) *Mastigophora*, with the subclasses *Flagellata*, *Dinoflagellata* and *Cystoflagellata;* (3) *Sporozoa* with the subclasses *Telosporidia* and *Neosporidia;* (4) *Infusoria*, with the subclasses *Ciliata* and *Suctoria*.

Recent investigations have demonstrated the responsibility of various species of *Protozoa* in the production of serious diseases among man and the domesticated animals. Thus malaria is caused by a form (*Plasmodium malariæ*) parasitic in the red blood-corpuscles, tropical dysentery is produced by *Entamœba histolytica*, and Texas fever of cattle is due to *Piroplasma bigeminum*. Surra in the Philippines, the tsetse fly disease in Africa, and other maladies of domestic animals are known to fall in the same category, while in man, smallpox, yellow fever, scarlet fever, spotted fever, dengue and other diseases less thoroughly investigated, are believed to be due to protozoan parasites. Consult Lankester, ‘A Treatise in Zoölogy’ Part I. (London 1903).

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Protrac'tor, an instrument for laying down and measuring angles on paper, and by which the use of the line of chords is superseded. It is of various forms — semicircular, rectangular, or circular.

Proud, Robert, American historian: b. Yorkshire 10 May 1728; d. Philadelphia, Pa., 7 July 1813. He came to America in 1759 and settled in Pennsylvania where he engaged as teacher of Latin and Greek in a Friends' Academy in Philadelphia. During the American Revolution he remained loyal to the crown, firmly convinced that the future of the new country would be ruined by the success of the American arms, and it was during the progress of the war that his work of greatest importance ‘The History of Pennsylvania’ (1797–8) was written. The work is of much value as containing original material and important information, but the narrative is not well sustained. Consult Thomson, ‘Life and Character of Robert Proud’ in ‘Memoirs of the Historical Society of Pennsylvania’ (Vol. I. 1826; 1864).

Proud Flesh. See Granulation Tissue.

Proud'fit, David Law (“Peleg Arkwright”), American author: b. Newburgh, N. Y., 27 Oct. 1842; d. 1897. He enlisted in the Union army as a private in 1862, was commissioned lieutenant-colonel of colored troops and served through the war. He afterward entered business, became interested in pneumatic tube experiments and later was president of the Meteor Dispatch Company. His publications include: ‘Love among the Gamins’ (1877); ‘Mask and Domino’ (1888); etc.

Proudhon, proo'dôn, **Pierre Joseph,** French philosophical anarchist: b. Besançon, France, 15 July 1809; d. Paris 19 Jan. 1865. He studied at the University of Besançon, but left without completing his course there because compelled to find some means of self support. He then learned printing and in 1837 became partner in developing a new typographical process. He had continued his education by improving every opportunity for study; and in 1838 published a philological treatise, 'Essai de Grammaire Générale,' for which the Academy of Besançon conferred on him a pension which yielded an income of 1,500 francs for three years. Political economy now became his chief study, and in 1840 appeared his famous work 'Qu'est-ce que la Propriété?' ('What is Property?'), to which question the first page of the treatise contains the answer, «C'est le Vol» («It is theft»). This first treatise was followed in 1841 and 1842 by two pamphlets in the same strain, the second of which, 'Avertissement aux Propriétaires,' led to his prosecution and trial for his revolutionary opinions, resulting in an acquittal. In 1843 Proudhon undertook the management of a system of transports on the Rhone and Saone. But he still continued to write. In that year appeared his treatise 'De la Création de l'Ordre dans l'Humanité,' a proposed system of political organization; and in 1846 'Système des Contradictions Economiques.' After the revolution of February 1848, he began the publication of a journal at Paris called 'Le Représentant du Peuple,' which, however, was speedily suppressed. But he had by this time acquired so much popularity that he was elected the representative of the Seine in the Assembly. Here however, he had little success, and again turned to writing and journalism. He published several pamphlets, and started three journals in succession, 'Le Peuple,' 'La Voix du Peuple,' and 'Le Peuple de 1850.' He was frequently fined for his statement of his radical theories, but the fines were paid for him by subscription. In 1849 he attempted to found a bank under the name of the «Banque du Peuple» with the object of abolishing interest and finally putting an end to capital. This project failed, and he fled to Geneva to escape imprisonment for violation of the press laws, but returning in June 1849, was imprisoned for three years. On his release in 1852 he went to Belgium, where he continued to write, and in 1860 under an amnesty returned to Paris, where he lived in retirement till his death. His publications in addition to those already mentioned include: 'Confessions d'un Revolutionnaire' (1849); 'Actes de la Révolution' (1849); 'Intérêt et Principal' (1849); 'Gratuité du Crédit' (1850), the last two a resumé of discussions he had had with Bastiat on the subject of interest; 'La Révolution Sociale Demontrée par le Coup d'Etat' (1852); 'Manuel de Spéculateur à la Bourse' (1856); 'De la Justice dans la Révolution et dans l'Eglise' (1858); 'La Guerre et la Paix' (1860); 'Théorie de l'Impôt' (1861); 'Les Majorats Littéraires' (1862). Several works of his have also been published posthumously, among them 'De la Capacité Politique des Classes Ouvrières' (1865); 'Théorie de la Propriété' (1865).

He was the first to formulate the doctrines of philosophical anarchism; he maintained that property was unjustifiable, that labor only should give just claim to share in the product of labor, and that consequently rent and interest should not exist. He thus far agreed with the socialist doctrine of value, but he was neither a socialist nor a communist; because the state depended upon and protected property he claimed that the state must be destroyed; and that the proper basis of society was a voluntary contract between individuals. Consult: Sainte Beuve, 'Proudhon, sa Vie et Correspondance' (1875); Diel, 'P. J. Proudhon, seine Lehre und sein Leben' (1888–96); Desjardins, 'Pierre Joseph Proudhon' (1896); Mulberger, 'P. J. Proudhon, Leben und Werke' (1899).

Proustite, or Ruby Silver, the most beautiful silver mineral and one of the most important ores of silver. It occurs in scalenohedrons, or, less commonly, in prismatic crystals, also massive. Its lustre is brilliant adamantine, typical color cochineal-red, but changing to nearly black on exposure to light, losing simultaneously much of its transparency. Chemically, it is silver sulpharsenite, the silver percentage being 65.4. In the rich silver mines of Chile it is one of the chief ores and magnificent crystallized specimens worth thousands of dollars have been taken out. The royal Saxon mines are also celebrated for their ruby silver, and it occurs as an ore in many European, Mexican, Colorado and Nevada silver mines.

Prout, prowt, **Ebenezer,** English composer and writer on musical theory: b. Oundle, Northamptonshire, 1 March 1835. He was educated at University College; d. 1909, and from 1860 till 1884 was a professor at the Crystal Palace School, and in 1876–82 professor at the National Training School for Music. He was a professor of harmony and composition in the Royal Academy of Music and the Guildhall School of Music, and from 1894–1909 occupied the chair of music in Dublin University. His compositions include cantatas, concertos, quartets, symphonies, etc., among the first named being 'Hereward' (1878); 'Alfred' (1881); 'Red Cross Knight' (1886); and 'Damon and Phintias' (1888). Among his theoretical works are the following: 'Instrumentation' (1876); 'Harmony' (1889); 'Counterpoint' (1890); 'Double Counterpoint and Canon' (1891); 'Fugue' (1892); 'Musical Form' (1893); 'Applied Forms' (1895); 'The Orchestra' (1898–9).

Prout, Father. See MAHONY, FRANCIS SYLVESTER.

Prout, Samuel, English painter: b. Plymouth 17 Sept. 1783; d. Camberwell 10 Feb. 1852. He early manifested a turn for drawing, but the only lessons he received were from a drawing-master in his native town. In 1801 he made the acquaintance of Britton, the architectural antiquary, who employed him in visiting the rural districts to make sketches, which were engraved in the 'Beauties of England.' In 1818 he visited Normandy, returning with many striking water-color drawings, whose merits placed him at the head of this department of art. He was especially happy in depicting monuments of mediæval architecture throughout France, Germany, and Italy, and also directed his attention to lithography, publishing several collections of lithographed sketches. He was a great water-color painter, in the English sense of the term, and relied altogether upon wash tones, whose depth was determined by the degree to which the white paper on which they were laid was permitted to appear. The principal features of his buildings he marked with strong lines and deep shadows, but his main characteristics are breadth, freedom of handling, and power of coloring. His industry was great and his pictures were eagerly sought for. In 1868 his 'Nuremberg' (21 x 28 in.) was sold for $5,010. He is the author of 'Hints on Light and Shadow' and the 'Young Student's Drawing Book.'

Provancher, Leon, Canadian naturalist: b. Besancour, Quebec, 10 March 1820. To devote himself exclusively to the pursuit of botany and kindred studies, he retired from the Catholic priesthood. He established 'Le Naturalist Canadien' in 1868, and published 'Elementary Treatise on Botany' (1858); 'Canadian Plant Life' (1865); 'From Quebec to Jerusalem' (1882); 'Short History of Canada' (1887).

Provençal (prō-vŏṅ-säl) **Language and Literature.** A curious natural feature of Dalmatia is the number of rivers which come up suddenly from underground, or burst full-grown from the bases of the hills, and seek the sea with a force and velocity of current all the more impressive from the mystery of their origin. Just so the poetry of the Troubadours leaps abruptly, in full volume, out of the murk of the unlettered ages, and spreads itself abroad in a laughing flood of which the superficial sparkle may sometimes deceive concerning the strength of the undercurrent passion on which it is upborne.

Gai Saber — the Gay Science — was the name bestowed by these gushing singers themselves upon their newly discovered art of verse-making; and the epithet was perfectly descriptive. To the serious, disciplined, and systematic 20th century mind, there is something incongruous, not to say indecent, in the association of science and joy. Whatever else the science may be, in whose sign we are supposed to conquer, it is not gay. But the Troubadour did not even know the difference between science and art. His era in the life of modern Europe corresponds exactly with the *insouciant* season when «a young man's fancy lightly turns to thoughts of love.» The Troubadour was palpitating, moreover, with the two masterful enthusiasms of his time: the religious enthusiasm of the Crusades, and the high-flown sentiments and noble chimeras of the lately formulated code of chivalry.

Seizing the instrument nearest to his hand, — a supple and still growing offshoot from the imperishable root of Latin speech,— he shaped his pipe, fashioned his stops, and blew his amorous blast; and overcome by amazement at the delightful result, was fain loudly to proclaim himself the happy *finder* (trobaire) of the verbal music he had achieved, rather than its *maker* or poet.

Lengua Romana, or *Romans*, was what he called his own language. To Dante, in the beginning of the 14th century, it was Provençal as distinguished from the *lengua materna*, or Italian; and Provençal it is, to this day, loosely called. But it was spoken in substantially the same form, far outside the fluctuating limits of mediæval Provence; and one of the Troubadours themselves — Raimon Vidal — has in fact defined its limits very explicitly. «The only true language of poetry,» he says, «is that of Limousin, Provence, Auvergne, and Quercy; . . . and every man born and brought up in those countries speaks the natural and right speech.»

The time at which the troubadour minstrelsy flourished is as distinctly marked as its locality. Two hundred years, from the last decade of the 11th century to the last of the 13th, comprise it all. Fifty years for its rise, a hundred for its most exuberant period, fifty more for its decline, — and the brief but picturesque and exciting story is all told. The love of man for woman is its perpetual and almost exclusive theme. The special form of the tender passion to which the troubadour tuned his lay was, however, the love of chivalry; theoretically a selfless and spiritual sentiment, having even a touch about it of religious exaltation. It involved the absolute devotion of life, wit, and prowess to the service of a formally chosen lady-love; and was as much a part of the sacramental obligations of a full-made knight as the service of God and of his feudal seigneur. The art in which this love found expression was thus essentially an aristocratic one; reserved for the practice of those who were either *élite* by birth and fortune, or ennobled by the possession of rare poetic gifts. Marriage was no part of its aim, and was never once, in the case of any well-known troubadour, its dénouement. The minstrel's lady was quite regularly the wife of another man; often of his feudal lord or sovereign ruler. The scope for tragedy and crime afforded by so fantastic a relation is obvious, and history has plenty to tell of the calamities which attended it in particular cases. Yet the austere ideal was never totally eclipsed; and that it survived the final disappearance of the troubadour as a court-minstrel and titular lover, we have abundant proof in the mystic lauds addressed by Dante to Beatrice and by Petrarch to Laura.

For the rest, the precocious perfection of form exhibited by some of the earliest troubadour songs which we possess, is not quite as miraculous as at first sight it appears. The main points in the mechanism of troubadour verse, both in its earlier and simpler, and in its later and highly elaborate developments, are two: strong tonic accents — mostly iambic, though sometimes of trochaic lines — and terminal rhymes. By these features it is radically distinguished from the quantitive measures of classic Greece and Rome; and in these respects it has furnished the model for almost all modern European poetry. But the rustic and popular poetry of the Latin race had been, from the first, a poetry of accent: and the tradition of it had been handed down through the early hymns of the Christian Church, and the rude staves and ballads trolled from town to town and from castle to castle during the Dark Ages, by the *joculatores* or *jongleurs;* those vagrant mimes and minstrels who played so large a part afterward, in diffusing and popularizing the more refined compositions of the troubadours. Rhyme, on the other hand, was very probably borrowed immediately from that Arabian verse in which it is so lavishly employed, during the long sojourn of the Saracens in southern Europe.

It seems a curious freak of philological fate whereby a literature so juvenile and impulsive as that of the troubadours, so destitute of connected thought, and at the same time so instinct with emotions, should have become — largely by virtue of its important historical position midway between the written word of ancient Rome and that of modern France — a favorite and hard-trodden field for dry research, grammatical quibbling, and controversy on technical points. But so it is. Every sigh of the troubadour minstrel has been analyzed, and every trill conjugated. Yet when all has been said and read, the reader's appreciation of this unique body of song will have to depend rather more upon personal divination and temperamental sympathy than upon any laboriously acquired skill in interpretation. Even for the name and lineage of many of the most famous and successful *finders,* as well as for the incidents of their lives, we are mainly dependent upon two sets of brief biographies, compiled by nameless monks, one in the 12th and one in the 14th century. Of these cloistered authors, the earlier was no doubt contemporary with a certain number of his subjects; but we may safely conclude that they both adorned their facts, to some extent, with fancy and with fable. In selecting, out of a hundred or two of these romantic lives, a few as typical of all, we may think ourselves fortunate if, as in the case of the name that heads all the lists, the poet be a sufficiently exalted personage to have had a place in general history, and to have borne a part in the leading events of his time.

William IX., Count of Poitiers and Duke of Aquitaine, born in 1071, succeeded in his 15th year to the sovereignty of a region comprising, besides Gascony and the southern half of Aquitaine, Limousin, Berry, and Auvergne. Almost alone among the great lords of southern France, he resisted the call of Raymond of Toulouse to the first Crusade in 1095; but when in the last year of the century the great news arrived of the capture of Jerusalem, and an appeal was made for the reinforcement of the small garrison left in the Holy Land, William was overborne, and prepared, though still reluctantly, to go. His amours had been numerous, and he had already written love songs,— many of which are licentious to a degree, though some few reflect in sweet and simple strains the most refined ideals of chivalry. On the eve of his departure for the East, early in 1101, he composed a farewell to Provence, being haunted by a sad presentiment that he should see that fair land no more. His foreboding was not realized. He lived until 1127, and made ruthless war in his later years upon his young and defenseless neighbor, Alphonse Jourdain of Toulouse, for the sovereignty of that province. Alphonse was a son of the heroic Raymond, the leader of the first Crusade, born in the Holy Land and baptized in the Jordan,— whence his surname. A daughter of his was distinguished by the tuneful homage of a troubadour named Guiraud le Roux, of knightly rank but poor, who had taken service at Alphonse's court. This Guiraud is remarkable as being the only troubadour on record who loved but one woman; and there is a quality about his whimsical and subtle but always irreproachable verses which reminds one a little of the Elizabethan lyric.

William IX. of Poitiers was succeeded by his son William X.; and he in turn was the father of one of the most illustrious women of her age, a great patroness of the troubadours, and past-mistress of all that nebulous lore which was made the absurd matter of solemn discussion and adjudication in the so-called Courts of Love. This was no other than Eleanor, Princess of Aquitaine and Duchess of Normandy, first married to Louis VII. of France, then divorced and married to Henry II. of England. She was already married to Henry, who was 10 years her junior; but she had not yet visited England when she welcomed and installed as her formal worshipper at the Norman court one of the most famous and prolific of all the troubadours, a true poet, though a light and inconstant lover, Bernard of Ventadour. Very humbly born, Bernard's exquisite talent was early discovered by his master, Ebles III. of Ventadour, who is described in the old chronicles as having «loved, even to old age, the songs of alacrity.» Ebles not only educated the boy, but permitted and even encouraged him, for a long time, to *afficher* himself as the adorer of his own youthful second wife, Adelaide of Montpellier. The day came, however, when the youth's homage was suddenly discovered to have passed the proper ceremonial bounds; and he was abruptly dismissed, to take new service in Normandy. It is next to impossible to separate, in his remains, the songs of the two periods: Adelaide or Eleanor, it is all virtually one. The limpid stream of babbling minstrelsy flows on for some 40 years, always dulcet and delicate, sometimes lightly pathetic, but reflecting indifferently the image of either lady. Within the long period of Bernard's placid ascendency were comprised the rapid and fiery careers of two men of a very different stamp,— the most tragical figures in all the miscellaneous choir.

Jaufré Rudel, the Prince of Blaya, fell in love with a certain Countess of Tripoli on the mere rumor of her charms; assumed the cross for the sole and sacrilegious purpose of meeting her; fell ill upon the voyage, and on his arrival was recovered from a death-like trance by his lady's embrace, only to die almost immediately in her arms.

The horrible story of William of Cabestaing would seem quite beyond belief were it not given circumstantially, and with very slight variations, by an unusual number of writers. An accomplished cavalier, William won such favor in the eyes of the Lady Margarida, wife of Raymond of Roussillon, that he aroused the savage jealousy of the latter, who slew him, and then cut out his heart, which he ordered cooked and seasoned and set before his wife. The hapless lady partook of it; then, on being brutally told the ghastly truth, swore that she would never eat again, sprang past her husband, leaped from an open window, and perished. Both Raymond and William were vassals of Alphonse II. of Aragon, himself a troubadour, and a great patron of the art. He had Raymond arrested, and caused him to die in prison; while the tomb of the lovers before the door of the church at Perpignan was long a place of pious resort for the pilgrims of passion in those parts.

A different and less melodramatic interest attaches to the names of the two Arnauts,— Arnaut Daniel and Arnaut de Maroill: of whom the former, as we know from Canto xxvi. of the

'Purgatorio,' spoke in Provençal to Dante when he met him in the shades; while the latter is mentioned by Petrarch in a canzone as "the less famous Arnaut." The distinction seems a strange one: for while the verses of the former are chiefly remarkable for an extraordinary artificiality and complexity of rhythm, the latter, who had vowed his devotions to a certain lovely Viscountess of Béziers, was the author of some of the most exquisitely tender bits of Provençal song which we possess. The laborious verbal conceits and metrical intricacies of Dante's Arnaut were imitated with great ingenuity, and even exaggerated, by Raimon de Miraval, who fought in the Albigensian war; during which so many of the local poets and their patrons fell, that a whole civilization seemed to perish with them. That cruel contest may be held to mark the beginning of the end of the Provençal school of song.

The name of a woman, the Countess Die, who also, like the royal Eleanor, presided over a Court of Love, remains attached to one plaintive lament much admired in its day; and another woman, though unnamed, was the author of the most artless and impassioned of all the peculiar class of poems known as *albas* or morning-songs.

Another very beautiful *alba* was written by Guiraut de Borneil, of whom it is said by his ancient biographer that he composed the first true *chanson,* all previous poets having made *verses* only. He won a weightier kind of renown by the virile force and fire of his *sirventes,* — didactic or satiric pieces,— in which he mourned the accumulated misfortunes of his country, or lashed the crimes and vices of the men who had brought her to the verge of ruin.

Contemporary with Guiraut was another intrepid censor of the corruptions of his time, Peire Cardinal; of whom we have a satire beginning with the burning words, "Who desires to hear a *sirventes* woven of grief and embroidered with anger? I have spun it already and I can make its warp and woof!" Both these brave men died not far from the year 1230, and the course of Provençal literature after their day is one of steady deterioration.

The Provençal language has been revived within the last 50 years as a literary instrument, a society having been formed in 1854 and organized in 1876 with the object of attempting "to bring together and to encourage those who by their writings preserve the language of the land of Oc, and also those scholars and artists who study and work in the interests of this region." Joseph Roumanille (q.v.) first conceived the idea of preserving and perfecting the dialect of his own region (Avignon) and in 1852 edited a collection of Provençal poems by many authors. Frederic Mistral (q.v.), a man of powerful poetic genius, has devoted life-long labors to the cause. The society soon after its organization in 1876 largely increased in numbers. Its members called themselves Félibres (Book makers) and included among the charter members Joseph Roumanille; Frederic Mistral; Theodore Aubanel; Eugene Garcin; Anselme Mathieu; Paul Giéra; and Alphonse Tavan. The club disseminated their views by means of an annual, 'Arnsana Prouvenceau' (which at present reaches a circulation of many thousands), and through it the public became ripe for the appreciation of Mistral's first long poem, 'Mierio,' published in 1859 and received in the literary circles of Paris with great applause. The movement spread to Spain and the Catalan poet and patriot Victor Balaquer received an ovation on his visit to Avignon in 1867. The Provençal of the Félibres is by no means the language of the Troubadours, but is based upon the dialect or patois of Saint Rémy, which was not derived from the Limousin dialect of the Troubadours. The language of Mistral, while rich in vocabulary, and full of local Provençal terms, is an artificial language, formed by rejecting all terms due to the influence of French and the French Academy and utilizing the tongue of the poet's native home. What makes the work of the Félibres live and prevail is the sheer superiority of its literary quality. Consult: Rutherford, 'Troubadours' (1873); Preston, 'Troubadours and Trouvères' (1876); Huffer, 'Troubadours' (1878); Meyer, 'Provençal Literature' in the 'Encyclopedia Britannica' (9th ed.); Diez, 'Leben und Werke der Troubadours' (2d ed. by Bartsch, 1883); Rowbotham, 'The Troubadours and Courts of Love' (1895); Farnell, 'Lives of the Troubadours'; Jourdaine, 'Histoire des Félibres.' For those who wish to study the Provençal texts in the original, the most convenient collection is Karl Appel's 'Chrestomathie' (Leipsic, 1895).

HARRIET WATERS PRESTON.

Provence, prō-vāṅs, an old province of southeastern France, bounded by Piedmont, the Mediterranean, Languedoc, Venaissin, and Dauphiné, and including what is now the departments of Bouches-du-Rhône, Var, Basses Alpes, and, in part, Vaucluse, and Alpes Maritimes. Lesser ranges of the Alps, called the Alpines and in the south the Maures break up the country. The principal rivers are the Var, Durance, and Rhone; the last river has a great marshy delta. Climate and soil vary greatly, from the damp, changeable, rather sterile, and stony north to the south with its ideally mild air, its culture of bees and silkworms, and its produce of olive-oil, wine, mulberries, oranges, citrons, and all southern fruits. There is good sheep-grazing, but other livestock is less successful. The inhabitants of the Provence preserve to a large degree southern characteristics quite foreign to the northern Frenchmen, and keep a language and literature of their own, nearly as much akin to the Spanish and Italian as to the French. (See PROVENÇAL LANGUAGE AND LITERATURE.)

History.— There are traces in Provence, as in the polished stones found in the Grotte de la Masque and elsewhere, the tumuli, and dolmens of Draguignan, Pontève and la Blaque, and the lake dwellings of the mouth of the Var, of a civilization as early as the middle of the Stone Age. The Iberians held sway here until the 5th century B.C., when they were finally displaced by the Ligures. Greek and Phœnician colonies, notably Marseilles (q.v.) had been founded here at least as early as this. The Greek city of Marseilles by its repeated appeals to Rome for help against the Ligures, first in 155 B.C., effected the introduction of Roman influence, and in 124 B.C. Marcus Fulvius, proconsul, and Gaius Sextius Calvinus, consul, destroyed the capital of the Saluvii and founded (123 B.C.) on its site the city of Aquæ Sextiæ (modern Aix). Victories over other tribes in the next few years gave all the country between the Cevennes and the Alps to Rome. A Roman province, Provincia *par excellence,* or Gallia Transalpina (or Narbonensis, from its capital Narbo, modern Narbonne), arose, was threatened 15 years later by the invasion of the Cimbri and Teutones, and was racked by the civil war between Cæsar and Pompey, in which Massilia (Marseilles) siding with the Senate was captured and crushed by Cæsar in 49 B.C. The amphitheatre of Fréjus, the theatres of Arles, Fréjus, and Orange, the triumphal arches of Orange, Cavaillon, and Carpentras, the temple of Augustus and Livia at Vienne, and the splendid Roman roads through southern France, are remains of the glory of Provence in the first four Christian centuries, when Arles was a great commercial centre and one of the residential cities of Constantine, and when Autun and Marseilles were great university towns, Marseilles being the seat of a Greek college and a medical school.

The Visigoths entered Provence in the beginning of the 5th century, and about 470 Eurich captured Arles and made it his capital. The Ostrogoths held Provence from 510 to 536, receiving it as the price of their protection against the Franks, but losing it after a quarter of a century to the growing Frankish empire. In the 9th century Provence was twice a kingdom, and from 934 to 1113 was ruled by the counts of Arles (or of Provence), descendants of Boson, whose line failing in 1113 the county went to Berengar of Barcelona. His claim was contested by the Count of Toulouse, who in 1125 by treaty secured Valence, Die, Orange, and Venaissin; what had been retained by Berengar went to Aragon in 1162, the Count of Barcelona having come to that crown in 1137. In 1246, Beatrice, daughter of Raimond Berengar IV., the last of the male line, married Louis of Anjou, and Provence was a possession of the House of Anjou until 1481, when it was willed to Louis XI. of France and lost its separate significance politically.

Consult: Oddo, ‘La Provence: Histoire, Usages, Coutumes, Idiomes, etc.’ (1902); Castanier, ‘Histoire de la Provence dans l'Antiquité’ (1893–6); and Marchand, article ‘Provence’ in ‘La Grande Encyclopédie.’

Prover'bial Philosophy, a once popular didactic work by Martin Farquhar Tupper, published 1838–67. It is a series of poems in blank verse, dealing with almost every emotion and condition of life. The book contains many wise sayings, but is for the most part merely padded commonplace.

Proverbs, Book of, a portion of the Old Testament. *Date and Authorship.*—The book of Proverbs is the subject of much discussion in reference to date and authorship. The old view that king Solomon was the author of nearly or quite the whole of the book has been generally abandoned. Two classes of views are widely held at the present day. One is that all of the book, or all but the last two chapters, was written and compiled before the Babylonian exile. The amount attributed to Solomon varies, but is in any case an appreciable quantity, forming the kernel of the whole. The other view is that both writing and compilation are to be dated long after the exile, no part having been written by Solomon. The completion of the work of compiling is assigned to various dates from about 350 to 180 B.C., the whole composition of the book being supposed to cover not more than a century. There is a growing tendency toward the second view, which is held by most of the very recent writers on the book.

Arguments for Late Date.— The chief argument in favor of the late date of the book is from language, that is, the occurrence of a considerable number of words found elsewhere only in late Hebrew, and of words borrowed from the Aramaic. But the number of words which can with certainty be assigned to these two classes is much smaller than is often claimed. Historical indications also urged for the same conclusion are that the book makes no mention of polygamy and idolatry, which were common before the exile, and that it assumes the existence of a distinct class of sages, known as wise men, who are hardly mentioned in the historical and prophetical books before the exile, nor are any results of their activity apparent. These are arguments from silence, and therefore must be used with great caution. The resemblance to the apocryphal book of Ecclesiasticus, which is also urged, has little bearing on the question, in view of the well-known habit of the author of Ecclesiasticus of borrowing from other books.

Arguments for Early Date.— In favor of the early date, the chief argument is the thought of the book. The oft-repeated teaching of the book concerning the problem of God's government of the world is this: the good will prosper, the wicked will be punished, in this life. This is generally acknowledged to be the pre-exilic doctrine, while that of the exile and after the exile is quite different. The adherents of the late date are obliged to suppose that the pre-exilic doctrine had persisted long after the exile, in face of the teaching then current that the wicked prosper and the righteous suffer. Further, the frequent allusions to a king harmonize only with the early date. Many passages speak of him as the promoter of justice, and none refer to him as a foreigner. After the exile the sovereignty of Palestine was in the hands of foreigners, with little justice in their administration. The syntax of the book, also, is of the classical, earlier, type. The titles in chapter i. 1; x. 1, and xxv. 1, which attribute portions of the book to Solomon represent at any rate a tradition, and should be given some weight. The preponderance of evidence seems in favor of the earlier date.

Divisions of the Book.—As ordinarily viewed, although with some variation, there are eight different portions into which the book is divided, each of which is a separate compilation. These divisions, in the chronological order usually, but not invariably, assigned to them, are as follows: Chapter x. 1, to chapter xxii. 16, containing the title in chapter x. 1, “The proverbs of Solomon.” Chapter xxii. 17, to chapter xxiv. 22, called in chapter xxii. 17, “the words of the wise.” Chapter xxiv. 23–34, a similar collection, of which it is said in chapter xxiv. 23, “These also are sayings of the wise.” Chapters xxv.–xxix., headed by the statement in chapter xxv. 1, “These also are proverbs of Solomon which the men of Hezekiah king of Judah copied out,” which division, however, some regard as older than chapter x. 1; xxii. 16. Chapters i.–ix., a connected discourse in praise of wisdom, in the form of advice to a son or scholar. Chapter xxx., with the title in chapter xxx. 1, "The words of Agur the son of Jakeh." Chapter xxxi. 1–9, described in chapter xxxi. 1, as the words probably should be translated, as "The words of Lemuel king of Massa." Chapter xxxi. 10–31, an anonymous alphabetic poem or acrostic in praise of the ideal housewife. The first division was probably compiled somewhat after the time of Solomon, the fourth is traditionally assigned to the time of Hezekiah, while the last three divisions probably belong soon after the exile. There are no indications of precise date for the other divisions, but on the view adopted all of them are to be regarded as pre-exilic.

Solomonic Authorship.— That the first and fourth divisions are not entirely the work of Solomon is indicated chiefly by the fact that there are many repetitions of proverbs partly the same, and by the further fact that some are not written from his standpoint, especially the utterances concerning the king. On the other hand, there seems to be no sufficient reason for denying that he is the author of many of them. There is no evidence, however, that Solomon wrote down his own proverbs, 1 Kings iv. 32, does not mention Solomon as *writing* proverbs, but as *speaking* them.

Literary Characteristics.— The Hebrew word for proverb (mashal) probably meant originally a *comparison*, and then was broadened to apply to any sententious saying, because often containing a comparison. The proverbs of this book do not bear in general the stamp of long popular use, but rather of the reflection of individuals. The whole book is written in what is called, from the Hebrew standpoint, poetry; for the most part gnomic, although the lyric form is also found, especially in chapters i.–ix. Like Hebrew poetry generally, parallelism of the members of a verse is the most prominent characteristic. Antithesis is found especially in chapters x.–xv. Each verse expresses usually an independent thought, except in chapters i.–ix. and chapters xxx.–xxxi., where connected discourse is found. Brevity and sententiousness of statement are implied in the very nature of a proverb, while simile, metaphor, and paradox are common. An extended personification of wisdom is found in the eighth chapter.

Purpose.— Although Proverbs has several authors and compilers, and much of it is disconnected in form, yet a marked degree of unity pervades the whole. The book confirms the statement of purpose in chapter i. 1–6, that it is intended to teach wisdom to men, especially to the young and inexperienced, but also to those who already have some knowledge of wisdom. Wisdom, however, is a comprehensive term, it includes all that is desirable in character, folly all that is undesirable. Its foundation is religious, it consists fundamentally in a right relation to God, "the fear of Jehovah is the beginning of wisdom" (chapter ix. 10). But all that pertains to humanity is included in the scope of wisdom, so that the book touches all phases of human life. Observation of the customs and habits of men, and conclusions therefrom, have a prominent place.

Relation to Philosophy.— Wisdom is thus practical rather than speculative. To speak of the book as philosophical, as some have done, is, therefore, misleading. The book, it is true, identifies virtue with knowledge. But this is done, not from a philosophical standpoint, but from a religious and practical one. For the practical purpose of the writers, men are divided into two classes, those who know the right and do it, and those who are ignorant of it and do not do it. The other class, always so common, consisting of those who know the truth and do it not, is simply ignored. The speculative element is wanting in the book. The teachings concerning wisdom often suggest philosophical speculations concerning the greatest good, but they are always religious, not philosophical.

Ethical Teaching.— The ethical teaching of the book is on a high plane. Ceremonial is occasionally alluded to, but the sages agree with the prophets that the external act has no value without an inner reality. When revenge is forbidden, chapter xx. 22, and chapter xxiv. 29, and kind treatment of enemies is enjoined, chapter xxv. 21, the standard approaches closely to that of the New Testament.

Bibliography.— Cheyne, 'Job and Solomon'; Davison, 'The Wisdom Literature of the Old Testament'; Frankenberg, 'Die Sprüche' (in Hand-Kommentar zum alten Testament); Horton, 'The Book of Proverbs' (in Expositor's Bible); Kent, 'The Wise Men of Ancient Israel'; Nowack, 'Proverbs' (in Hastings' Dictionary of the Bible); Perowne, 'The Book of Proverbs' (in Cambridge Bible); Strack, 'Die Sprüche Salamos' (in Kurzgefasstes Kommentar); Toy, 'A Critical and Exegetical Commentary on the Book of Proverbs' (in International Critical Commentary); and 'Proverbs' (in 'Encyclopedia Biblica'); Wildeboer, 'Die Sprüche' (in Kurzes Hand-Kommentar zum alten Testament); Zöckler, 'The Proverbs of Solomon' (in Lange's Commentary).

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Providence, R. I., the county-seat of the county of the same name and the capital and largest city of the State, is situated at the head of what is called Providence River, a tidal arm of Narragansett Bay. It is 35 miles north from the open ocean, about 20 west from Fall River, 40 southwest of Boston and 157 northeast of New York. It covers an irregular area of 146 square miles. The early settlement was on the river at the mouth of two small streams, and for nearly 200 years it grew in an easterly direction, many of its finest residences being erected on the high hill overlooking the Providence River, this hill or ridge about 200 feet high dividing the valley of the two streams from that of the Blackstone or Seekonk, a river of some size. Later on the settlements began to extend in a westerly direction over low and rolling ground, and to-day the West Side, as it is called, is the most densely populated section of the city; though within the past few years a movement has again set in toward the east, a large area having been built up in that part of the city adjacent to and running west from the Seekonk.

Climate and Health.— Situated near the sea the city has a rather humid climate with a considerable range of temperature, but the weather is neither as hot in summer nor as cold in winter as in places farther inland. The prevailing winds in summer are from the southwest and in winter from the northeast or northwest. The city is more healthful than many large manufacturing cities and has been noticeably free from epidemics of serious diseases. The death rate in 1902 was 18.75 per 1,000 and in 1903 21.05.

Commerce and Manufactures.— In 1681 Providence was the most compact settlement of the colony of which it was a recognized centre; but its commercial growth for the ensuing hundred years was not as rapid as that of Newport, which, on account of its geographical position, was better adapted for the maritime trade of the East Indies, China, and the western coast of Africa.

Providence, however, eventually became considerable of a seaport town, and for many years the wealth of the city was mainly derived from its commerce of the seas. With the growth in size of the freighters of the coastwise and trans-Atlantic trade, and a proportionate lack of increased facilities for accommodating these larger vessels, Providence began about 1840 to lose its prestige in the shipping world, until finally its foreign maritime trade entirely disappeared. It can hardly look for its return, until the city, State or private owners of water front privileges, provide suitable accommodations for the handling of that trade, which by reason of the natural advantages of a magnificent harbor, easily entered, it should enjoy.

Chief among the advantages of Providence as a centre of industry, commerce, and trade, are those pertaining to its geographical position, it being the natural outlet of southern New England, and the sources of supply and distribution which are the natural outcome thereof.

Though its reputation as a shipping port has gone, to-day Providence is one of the great industrial centres of the United States, noted for the variety of its manufactured products, the greatness of its industries, the skilled workmanship of its artisans, and for the invention of those numberless ingenious accessories of modern life which have become necessities in this age of luxury. Preeminent among the varied industries of the city is the manufacture of jewelry with its allied interests, such as chasers, electroplaters, gilders, engravers, colorers, enamelers, die-sinkers, etc., approximating a total of 250 establishments, engaged in a manufacturing industry whose products are distributed alike among the civilized and uncivilized nations of the earth. The value of the products of these establishments in 1812 amounted to $100,000; increasing in 1900 to $12,719,124, or 27.4 per cent of the entire value of the production of all the manufacturing establishments in Providence.

Allied to the jewelry manufacture is the manufacture of silverware. It was an apprentice of the founder of the jewelry industry who began the manufacture of silverware in Providence, and founded what is now one of the largest establishments in this line of manufacture in the world. There were eight establishments engaged in this industry in 1900, located in Providence, with a capital of $5,127,714, an increase over 1890 of $2,125,482, or 70.8 per cent. These establishments gave employment to 1,540 wage-earners, to whom $978,198 was paid in wages, and their product was valued at $3,834,408, an increase of $1,324,539 since 1890, or 52.8 per cent.

The refining of gold and silver sweepings is closely dependent upon the two industries just described. Until 1850 the material used in this industry was allowed to go to waste. There are now 10 establishments engaged in this industry in Providence, with an invested capital of $505,957, and a product valued at $3,484,454.

Chief among the great corporations which claim this city as their home, are those of B. B. & R. Knight, operating nearly 500,000 spindles, largest in the world in the productive cotton goods line; the Gorham Manufacturing Company, manufacturers of gold, silver, and bronze works of art; the Brown & Sharpe Manufacturing Company, manufacturers of every class of fine tools and machinery, and the American Screw Company, established in 1838, said to be capable of supplying the world with the commodity it manufactures.

In 1839 the manufacture of files was begun in Providence, but it was to the invention by a local mechanic in 1864 of machinery for this manufacture, that the present importance of this industry in the city is due. The product of the industry in 1900 amounted to $1,033,838, the Nicholson File Company, the largest corporation of its kind in existence, representing practically the entire output of files and rasps in Rhode Island. Here is also located the New England Butt Company, manufacturers of machinery for insulating electrical wires and cables, single, double, and triple braiders, cabling, stranding, winding, and polishing machinery, and cable covering braiders; the Rhode Island Tool Company, makers of high-grade bolts and nuts; the Rhode Island branch of the American Locomotive Company; the Corliss plant of the American and British Manufacturing Company, the original home of the Corliss engine which won the admiration of the industrial world at the Centennial in Philadelphia in 1876; a plant in which to-day is also manufactured the Diesel oil engine; the Providence Belting Company, manufacturers of leather belting; the Davol Rubber Company, established in 1874, manufacturers of fine goods in hard and soft rubber; the Providence Machine Company, manufacturers of improved cotton and worsted roving machines; the Almy Water Tube Boiler Company, makers of Almy Patent Sectional Water Tube Boilers; The Builders Iron Foundry; the Barstow Stove Company; the Queen Dyeing Company, with a world-wide reputation for its fast blacks; the American Ship Windlass Company, and scores of other manufacturing plants smaller in size.

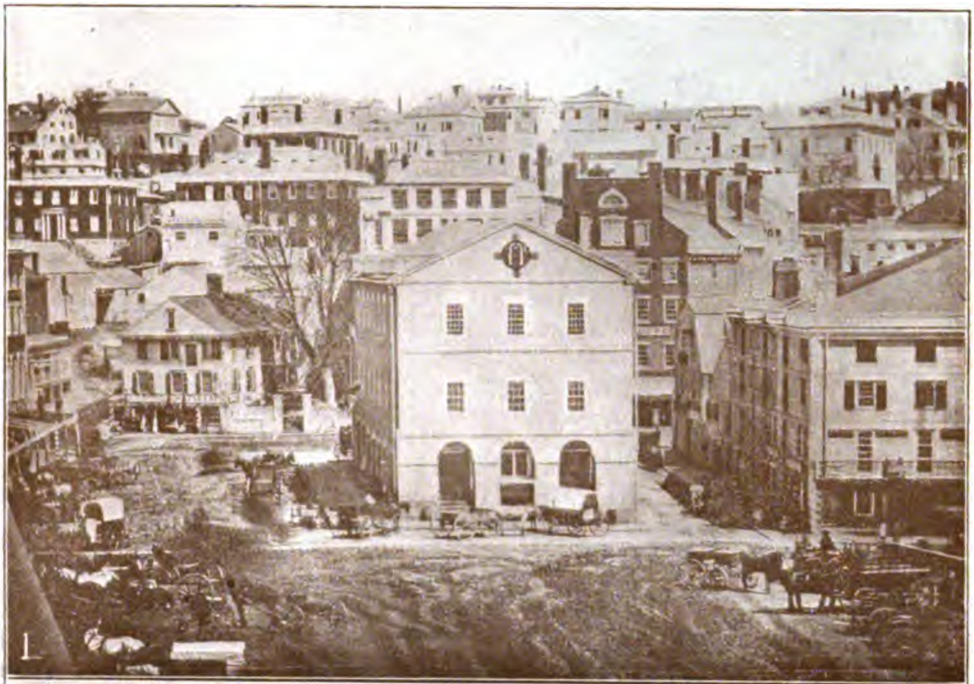
The total capital invested in the manufacturing of woolen fabrics in the city of Providence approximates $15,000,000, the number of wage-earners employed being about 8,500; the value of annual products being approximately $16,000,000.

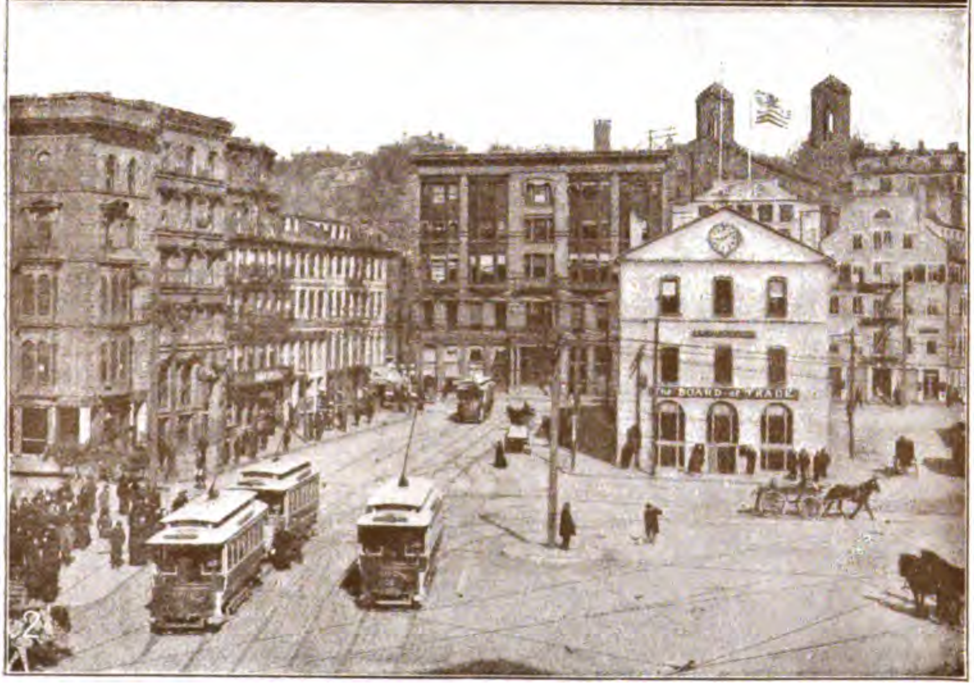
In cotton fabrics and other textiles, the total capital invested is a little more than $2,000,000, the average number of wage-earners employed being about 1,700; wages amounting to $452,182; the value of annual product being approximately $2,250,000.

In connection with textile products, there are in Providence a number of plants producing textile mill machinery and metal mill supplies, with a total capital invested of nearly $1,500,000, employing something over 1,000 hands, whose annual wages amount to $500,000; the value of annual product being approximately $1,500,000.

The financial strength of the city is concentrated in its manufacturing as has been shown. There are, however, other industries and enter-

PROVIDENCE.





1. Market Square, 1844. 2. Market Square, 1903.

prises of the highest importance, notably woodworking and lumber, including furniture, iron foundries, drug and dyewood mills, bleachers and dye-houses, boiler-makers, box makers, and brass founders, gas, steam, and water fittings, patent medicine manufactories, stove founders, assayers and refiners and the extensive trade in cotton and wool, groceries, dry-goods, hardware, clothing, etc., which is carried on with great success and employs an army of workers.

In 1790 there were made in the households of Rhode Island 30,000 yards of woolen cloth, 25,265 yards of linen, and 5,858 yards of cotton; but the introduction of power spinning marked the commencement of a period of change in manufacturing from the old handicraft system to the modern factory system, the first introduction of this factory system being applied to the making of cotton yarns in the year 1790. From this time on manufacturing establishments began to increase in number, until about 1840 when Providence began to enjoy that wide reputation in the manufacturing world which gradually increased, until to-day the number of her manufacturing establishments is about 1,950; capital invested about $84,000,000; average number of wage-earners 45,000; total wages about $20,000,000; gross value of products about $88,500,000.

In 1900 the census office reported that the percentage of population in Providence increased from 37.9 per cent in 1880 to 41 per cent in 1900, while the percentage of the number of establishments decreased from 54.6 per cent in 1800 to 46.1 per cent in 1900. The products of the city formed 40.9 per cent of the total in 1880, this percentage increasing to 61.4 per cent in 1890 and decreasing to 42.4 per cent in 1900.

These percentages indicate that the tendency has been to a wider distribution of manufactures, decreasing the percentage in the principal cities.

The commercial growth of the city for the past 50 years has not been phenomenal, but it has been a healthy advancement in capital invested, and in value of products, reflecting the solidity of the business interests here centred. The perpetuity of the high standing of the manufacturing and commercial interests of Providence is unquestionable, and the continued growth of this city, its trade and commerce founded upon sound business principles is assured, as is the high position it occupies in the financial world.

Banks.— Steadily the trend of banking interests is making toward the absorption of the smaller institutions by the larger, in Providence as in other large cities.

To-day (1904) the Providence Clearing House numbers 21 banks and trust companies, whereas when the clearing-house was established there were 34.

The Providence bank clearings for 1903, amounting to $354,165,000, were the largest ever recorded.

There are in Providence 15 national banks, 2 state banks, and 6 trust companies, with an aggregate capital invested amounting to $12,561,000. There are four savings banks in Providence whose combined deposits aggregate $45,000,000, the deposits of the national and state banks and trusts amounting to $87,500,000.

Soon after its passage in 1864, most of the state banks of Rhode Island availed themselves of the provisions of the Act of Congress, by which they became known as national banks. Within the last 50 years many private banking houses have been established in Providence, that have exerted considerable influence in financial circles.

The first savings bank established in this city, the Providence Institution for Savings, was incorporated in 1819, the oldest bank being the Providence National, chartered in 1791; the next oldest bank after the Providence Institution for Savings, being the People's Savings Bank.

Population.— The population of the city in 1902 was 181,000. In 1900 out of a total population of 175,597 there were 55,853 persons of foreign birth and 101,585 of foreign parentage. A majority of those of foreign birth came from the United Kingdom. The 101,585 persons of foreign parentage included 42,791 of Irish, 13,481 of English, 8,808 of Italian, and 6,000 of French Canadian parentage. The growth of the population since 1800 is shown by the following figures: (1800) 7,614; (1820) 11,767; (1840) 23,171; (1860) 50,666; (1880) 104,857; (1890) 132,146. In June 1890 a part of the town of Johnson was annexed to the city of Providence, thereby increasing the population approximately 8,500. Population (1910) 224,326.

A manufacturing city is seldom a city of home-owners, and Providence is no exception. In the population of 175,597 in 1900 there were 38,516 families, and of these but 4,087 families owned their homes free, while 29,696 families lived in hired homes.

Schools and Colleges.— On the ridge in the eastern side of the city stand the buildings of Brown University. Some of the quaint brick dormitories are over 100 years old, while the fine gymnasium and science laboratories were built but recently. (See BROWN UNIVERSITY.) Near by is the school for boys and girls founded by the Society of Friends in 1818. Other educational institutions in the city are the State normal school and the Rhode Island School of Design. The city has 100 public day schools as follows: 4 high schools, including a manual training school, 15 grammar, and 78 common schools, 8 schools for individual work, and 3 schools for backward children. The total number of teachers is 866, and at the last census there were 34,281 pupils. There are 18 evening schools and 24 kindergarten schools. The total number of children of school age, 5 years to 21 years, in 1900 was 47,928, of whom 40,090 were native- and 7,838 foreign-born; of these 26,416 were attending schools. The number of illiterate persons among those of native white parentage is very small, being but 180 in 1900; in that year the total number of illiterates was 10,029, of whom 8,607 were foreign born.

Clubs.—A number of clubs include in their membership the leading business and professional men of the city. The more prominent clubs are the Hope, Union, University, Central, West Side, Squantum, and Pomham. The two latter have elegant club-houses on the shores of the bay, some miles below Providence, and have numbered some famous men among their guests.

Chief Buildings.— By far the most imposing structure in the city is the new State House, a massively proportioned building, built of white marble with a large central dome. It was occupied first in 1900. The city-hall, a heavy granite structure; the county court-house; the public library; the English high school buildings; and the Roman Catholic cathedral of Saint

Peter and Saint Paul are also worthy of note. The new union railway station, while not imposing, is commodious, pleasing in outline, and remarkably well designed. Of modern office buildings Providence has comparatively few for a city of its size, chiefly because its great manufacturing firms have offices at their works. There are, however, a number of commodious, substantial office buildings of modern construction, chief among which are the Bannigan Building, the Industrial Trust Building, the Union Trust Building, Butler Exchange, the Francis Building, the Studley Building, the Swarts Building, the Providence Washington Building, the Vaughan Building, the Lauderdale Building, Mercantile Block, the Tierney Building, the Equitable Building, the Barton Block, the Merchants Bank Building, the National Exchange Bank Building, the Lederer Building, and the Fletcher Building; other buildings of note are the Y. M. C. A. Building, the Manufacturers' Building, the Athenæum, the Puplic Library, and four of the largest department stores in New England, equaling any in metropolitan cities, namely, The Boston Store, Shepard's, O'Gorman's, and the Outlet. The Arcade, an old structure, was famous in its early days. In Exchange Square, fronting the railway station, stand the Soldiers' and Sailors' Monument, the handsome Bajnotti fountain, and an excellent equestrian statue of Gen. Ambrose E. Burnside. In Cathedral Square stands the Doyle Monument, erected in memory of the late Thomas A. Doyle, for 18 years mayor of the city of Providence; a man who, in his day, did more than any other individual to broaden and strengthen the commercial interests of the community of which he was the figure-head.

Hospitals and Charitable Institutions.— One of the first hospitals for insane persons established in this country, the Butler Hospital for the Insane, stands in beautiful grounds in the eastern part of the city on the Seekonk River. Other hospitals and asylums are the Rhode Island Hospital, the Rhode Island Homœopathic Hospital, the Dexter Asylum for Poor, Saint Joseph's Hospital, and the State Institution for the Deaf.

Libraries.— One of the first public libraries in America is now represented by the Providence Athenæum which has some 62,000 volumes. The Public Library contains some 90,000 volumes housed in a handsome building recently erected. Other libraries in the city are the library of Brown University and those of the Rhode Island Historical Society, the Rhode Island Medical Society, and the Young Men's Christian Association.

Churches.— Providence is the seat of an Episcopal and of a Roman Catholic bishop. The Roman Catholic cathedral of Saint Peter and Saint Paul is perhaps the most imposing church building in the city. Grace Church, almost cathedral in its interior decorations and arrangement, is known as the Bishop's Church of the Episcopal Diocese. The First Baptist Church associated from a religious point of view with Brown University since Revolutionary days, is an imposing reminder of the architecture of the period in which it was designed by Sir Christopher Wren. Saint John's Church, on North Main Street, is one of the oldest Episcopal churches in New England, and the Beneficent Congregational Church, more commonly known as "The Round Top Church," on Weybosset Street, has long been associated with the religious life of Providence. Other churches whose edifices are both imposing and attractive are, the Church of the Mediator and the First Universalist, the Union Congregational, the Central Congregational, the Central Baptist, the First Congregational, the Trinity Methodist Episcopal, All Saints' Memorial, and Saint Stephen's Episcopal. The total number of religious buildings, churches, chapels, and missions in the city is 128, 110 of these being of various Protestant denominations and 18 Roman Catholic.

Parks.—There are altogether 18 parks in the city, having a total area of 530 acres. Of these Roger Williams Park is the largest, covering 103 acres. It contains a pretty little lake, children's play-grounds, a bronze statue of Roger Williams, and for its size is one of the most attractive city parks in this country.

Streets.—There are 235 miles of streets, of which 189 miles are covered with broken stone or gravel, 31 with granite blocks, 5 with cobblestones, and 5 with asphalt.

Government.—The mayor is elected annually. A board of aldermen and a common council form the legislative. Most administrative officers are elected by the council, as are three park commissioners, the license and fire commissioners. The commissioner of public works is appointed by the mayor. The police force is under the direction of a police commissioner appointed by the State legislature.

Finance.— The assessed valuation of the city in 1910 was $259,145,060 for both real and personal property. The tax rate is $16.50 per $1,000. The city expenses now amount to about $3,465,000 annually, of which $740,000 is spent on schools, $640,000 for the interest on the city debt; $370,000 on the police department; and $355,000 on the fire department. The city obtains its water supply from the Pawtuxet River; the system cost $7,100,000 and includes 333 miles of distributing mains. The sewage of the city is emptied into Providence River some distance below the city, and there are in the city 192 miles of sewers. At the precipitation plant just north of Fields Point, the sewerage of the entire city is gathered into immense basins or tanks, where it is filtered, clarified, and emptied into the river a considerable distance below the point. This plant is of modern construction, and is considered one of the best in the country, having been erected by engineers of national reputation after a careful study of surrounding conditions.

Public Utilities.—The water, sewage and park systems of Providence have already been noticed. The local electric railway system is one of the best in the United States, and branches out into every accessible part of the adjoining towns. The Union Railway Company and the Providence Tramway Company have practically a monopoly of the streets used for transporting passengers and freight by electric-propelled cars. Their exclusive franchise lasts for 20 years from 1891, the conditions being the payment of a franchise tax not exceeding 5 per cent on gross earnings, and the maintenance of a portion of the streets which they occupy. The Providence Gas Company has an exclusive right for the same period to supply illuminating and heating gas within the city limits. It pays a franchise tax of 3 per cent on gross earnings, after paying 8 per cent on capital stock, and making reasonable provision for maintenance and extension. If there is still a balance it is to be applied to reduction of the price of gas. The Narragansett Electric Lighting Company has an exclusive right for 20 years from 1892 for the supply of electric light in the city, the franchise tax not being less than 3, nor exceeding 5 per cent, this being determined each five years by arbitration.

History.— Providence was founded by that great apostle of religious liberty for the New World, Roger Williams, who arrived from England in Massachusetts Bay Colony in February 1631. He was well received by the Puritans, as a «godly minister,» but because of his boldness in announcing his views regarding the power of magistrates in religious matters he was forced to seek refuge with the Pilgrims at Plymouth. Subsequently he went to Salem, where his convictions regarding religious freedom incurred the displeasure of the general court, and in January 1636 he was ordered to return to England; he refused and fled into the wilderness. Accompanied by five other men from Salem he had no fixed abode for weeks, but in June 1636 he began a settlement at a point a little north of the present site of Saint John's Church in Providence. Williams obtained a grant to lands covering what is now that part of Rhode Island west of Narragansett Bay, from the Indians, the earliest deed on record being a memorandum dated 24 March 1637. In 1640 articles of agreement were adopted by the settlers as the basis of the town government, all affairs being regulated by a monthly town meeting. A royal charter was obtained in 1644 uniting various settlements about the bay, as «Providence Plantations in the Narragansett Bay in New England.» Providence being on the mainland and more exposed to the attacks of Indians, grew less rapidly than Newport on the island of Rhode Island, and in 1676 was nearly deserted. Less favorably situated for shipping than Newport, Providence grew but slowly; in 1730 the population of Providence, which included four settlements, was 3,916. In 1750 the population of Newport was twice that of Providence, and in 1774 the population of the town of Providence proper was but 4,321, though by this time the population of Providence County was greater than that of Newport County.

The first notice of a school house in the town records appears in 1752. A charter for a college was granted in 1764, and Providence County raising the most money, the first building was erected at Providence in 1770. This was the beginning of Brown University. Providence was one of the first towns in America to have a public library, a set of books having been bought by subscription before 1754 by a company formed for that purpose. During the whole of the 18th century Providence was a quiet community, where people lived simply with few amusements. The first theatrical performance was given by an English company in 1762.

The first fire engine was purchased about 1755. The first advertisement of a regular stage line to Boston appears 1767; the stage made weekly trips. The first public market-house was erected in 1773.

In the disputes with England that preceded the outbreak of the Revolution, Providence took a considerable part. The first overt act of resistance to England was the destruction of the armed schooner Gaspee in 1772. During the Revolution Newport was occupied by the British from 1776 to 1779, and the commerce of Providence was almost cut off by the British fleet, though a number of privateers hailing from Providence preyed on English commerce.

After the Revolution commerce slowly moved again, trade being with Europe, China, and Central and South American ports. In 1801 a fire destroyed property valued at $300,000, and in 1815 a great gale wrecked many vessels and did damage to the amount of $1,000,000. From this time on the growth of Providence was steady if not rapid, the population about doubling every 20 years. Government by town meeting proving inadequate to meet the public needs, a city charter was adopted in 1831. The history of Providence during the 19th century is largely that of industrial progress in this country, and reference to the great manufacturing establishments of the city is made elsewhere.

Bibliography.— Bayles, 'History of Providence County' (1891); Greene, 'The Providence Plantations for Two Hundred and Fifty Years' (1886); for early history a brief historical sketch in Vol. XVIII. of the Tenth United States Census. The 'Early Records of the Town of Providence' has been published in 15 volumes (1892–9).

George H. Webb,
Secretary Chamber of Commerce.

Providence, Sisters of, a religious order of the Roman Catholic Church, founded in France, according to some accounts in 1806, to others in 1820 (Sœurs de la Charité de la Providence), by Pastor Dujarrié in the parish of Ruielé, diocese of Le Mans (department of Sarthe). It gradually extended beyond this parish, and was authorized in 1826. A colony from Ruielé opened the first institute of the order in the United States on 22 Oct. 1840 at Saint Mary's, near Terre Haute, Vigo County, Ind. Establishments are conducted by the order in the archdioceses of Baltimore, Boston, and Chicago, and in the dioceses of Fort Wayne, Grand Rapids, Indianapolis, and Omaha. In 1904 the order had charge of 67 parochial schools and 20 academies for higher education. In 1909 there were 46 establishments of the order, the mother-house being at Saint Mary's, Vigo County, Ind.; and 800 members.

Providence Plantations. See Rhode Island, *History.*

Province, is a territory, section or district of a nation or government. Among the Romans a province was a district of conquered country, governed by a proconsul or proprætor. The first Roman province was Sicily, 241 B.C. From the time of Augustus they were divided into the senatorial provinces, and the imperial provinces. The latter comprised those which were most exposed to hostile inroads, and the administration of which was left entirely to the emperor under the pretense of sparing the senate and people the trouble of managing them, but in reality to keep the army in his own hands. Under the empire the provinces were much better governed than they had been under the republic. One reason of this was that the emperors were more disposed to pay regard to the complaints of the provinces than the republican courts had been, for the latter were largely composed of men who had themselves profited, or who hoped to profit, by the same kind of maladministration with which the governors were charged, and were therefore always willing if possible to connive at such offenses. In addition to this the provincial governors under the empire received fixed salaries, which lessened the temptation to resort to illegal exactions to indemnify themselves for the expenses that they necessarily incurred in soliciting the office that was an indispensable condition of their governorship.

In modern times the term has been applied to colonies or to dependent countries at a distance, or to the different divisions of a kingdom itself. The name has sometimes been retained by independent states. Thus, the Republic of Holland, after it had thrown off the Spanish yoke, was called the United Provinces; and the Argentine Republic used to be called the United Provinces of La Plata. In the canon law the term is applied to the jurisdiction of an archbishop. In the Roman Catholic Church it is also given to the territorial divisions of an ecclesiastical order such as the Franciscans, as well as to those of the Propaganda.

Province House, a brick mansion in Washington Street, Boston, Mass., built in 1679, and occupied by numerous colonial governors. It was burned in 1864.

Prov'incetown, Mass., town, Barnstable County; at the extremity of Cape Cod, on Cape Cod Bay and on the New York, New Haven & Hartford railroad. It was in the harbor of Provincetown that the Mayflower anchored in 1620 before going to Plymouth (q.v.), and that the Pilgrims prepared the compact by which their colony was to be governed. The town was not settled till 1680 and was incorporated in 1727. It has a large harbor, deep and well sheltered; it was formerly an important whaling town, but this industry has greatly declined. Its cod and mackerel fisheries are now its leading industries and there are several wholesale fish houses; it also contains oil factories, and small vessels and fishermen's boats are built. It has also been growing in popularity as a summer resort, and contains several hotels. It has a public library and a public high school. Pop. (1910) 4,369.

Provo (prō'vō) **City,** Utah, county-seat of Utah County; on the Provo River, and on the Oregon Short Line and the Rio Grande Western R.R.'s; about 45 miles south of Salt Lake City. It was settled in 1849, and in 1851 was chartered as a city. It is in a region in which the principal occupations are agriculture, stock-raising, and cultivation of fruit. The chief manufactures are flour, lumber, tin and iron roofing, woolen goods, and canned fruit. There is a large trade in farm products, live-stock, fruit, lumber, and in the importing of groceries and textiles. The place is visited by many tourists on account of the Provo Cañon, Utah Lake, and Bridal Veil Falls in the vicinity. It has the State Insane Asylum and a Mormon tabernacle. It is the seat of the Brigham Young Academy (Mormon). Pop. (1890) 5,159; (1900) 6,185; (1910) 8,925.

Provoost, prō-vō', **Samuel,** American Protestant Episcopal bishop: b. New York 11 March 1742; d. there 6 Sept. 1815. He was graduated at King's College (now Columbia) in 1758, went to England to prepare for ordination, studied at Cambridge University, and was ordained deacon and priest in 1766. Returning to America, he became rector of Trinity Church, New York, the second of four successive rectors who were raised to the episcopate. Throughout the Revolution he took a firm stand in favor of the liberty of the colonies, and was chaplain to Congress in 1785 as well as to the United States Senate in 1789. After presiding at the general convention held in Wilmington in 1786 (the absent Seabury being the only bishop in America), he set sail for England in company with William White to receive Episcopal consecration. A special act of Parliament having been passed empowering the archbishops of Canterbury and York "to consecrate to the office of a Bishop persons being subjects or citizens of countries out of His Majesty's dominions," Provoost and White were consecrated by these prelates and the bishops of Bath and Wells and Peterborough in the chapel of Lambeth Palace, 4 Feb. 1787. Bishop Provoost resigned his see in 1801, but the House of Bishops declined to receive his resignation, giving consent, however, to the consecration of Dr. Benjamin Moore as assistant bishop. He was buried in Trinity churchyard.

Prov'ost, one who is set over others; one who is appointed to superintend or preside over something; the principal, head, or chief of certain establishments or bodies; applied to (1) a jailer; the keeper of a prison; (2) the heads or principals of several colleges in the English universities of Oxford and Cambridge; the principal of the University of Dublin.

Provost-marshal, in military affairs, an officer who takes cognizance of offenses against discipline, orders the arrest and the punishment of deserters and other offenders according to the sentence of a court-martial, and maintains order generally. See COURT-MARTIAL; MILITARY LAW.

Proxy, the agency of one person who acts as substitute for another. In Great Britain every member of the House of Lords was formerly permitted, on obtaining a nominal license from the crown, to appoint another lord of Parliament his proxy to vote for him in his absence. Only a spiritual lord could be proxy for a spiritual lord, and a temporal for a temporal lord, and no peer could hold more than two proxies at the same time. Proxies were never used in judicial business, or in committees of the House, nor could a proxy sign a protest. The practice of admitting proxies was discontinued in 1867. Shareholders in joint-stock companies may vote by proxy.

Prud'hommes, Conseils de, kŏn-sā-ē dė prū-dōm, courts of conciliation in France for deciding small disputes between workmen and employers. The first councils called by this name in Paris were formed in 1296 in the reign of Philippe le Bel, when 24 *prud'hommes* were appointed to assist the provost of the merchants in settling disputes between merchants and manufacturers at the fairs and markets. After the revolution of 1848, at which period 75 towns had conseils de prud'hommes, the whole legislation on this subject was revised. All the patrons and workers of industrial establishments within the circle of jurisdiction of the council of prud'hommes were made eligible as electors. In June 1853 a law was passed which, with some modifications, is still in force. The patrons and the workmen are formed into separate electoral colleges, for the latter including managers and foremen, each to elect an equal number of prud'hommes. The general council, besides the president and vice-president, is composed of an equal number of patrons and workers. The jurisdiction of the councils is summary and without appeal for sums under 200 francs; above that sum an appeal lies to the tribunals of commerce. The presidents and vice-presidents of the conseils de prud'hommes are appointed by the executive power, and need not belong to either of the classes from which the other members are chosen. The number of conseils de prud'hommes is now about 140.

Prud'den, Theophil Mitchell, American physician and author: b. Middlebury, Conn., 7 July 1849. He was graduated from the Sheffield Scientific School, Yale, in 1872. Besides contributing to the scientific literature of bacteria and their influence in disease, he has written entertainingly on these and other scientific topics for the general public. He is professor of pathology in the College of Physicians and Surgeons, New York. Among his writings are: 'Manual of Normal Histology;' 'Handbook of Pathological Anatomy and Histology' (1885), with F. Delafield; 'Story of the Bacteria' (1899); 'Dust and its Danger'; 'Water and Ice Supplies' (1891).

Prudentius, proo-dĕn'shĭ-ŭs, **Aurelius Publius Clemens,** Christian hymn writer: b. Spain, probably at Saragossa, about 350; d. 410. He practised the profession of an advocate, and afterward became a functionary of the government. From a life of pleasure and worldliness he was reclaimed by his conversion to Christianity, retired to a cloister in his 57th year, and there spent the remainder of his life. It was during these latter years that he wrote the religious poems which have made his reputation as the greatest Christian poet of the 4th and 5th centuries in the Latin Church. This was the golden age of Latin patristic letters, and his contemporaries included Ambrose, Jerome, and Augustine. It is quite evident that he was a profound student of classic latinity, for he shows a complete mastery of the epic and lyric metres of Roman literature, and at the same time these poetical works are purely Christian, full of devotional feeling and theological lore. His 'Liber Cathemerinon' consists of 12 religious poems for daily use; while 'Psychomachia' is an allegorical description of the struggle between good and evil in the human soul. 'Peri Stephanon' is a metrical martyrology. Consult Glover, 'Life and Letters in the Fourth Century' (1901).

Prud'hon, Pierre, pē-ār prü-dôṅ, French painter: b. Cluny, Saône-et-Loire, 4 April 1758; d. Paris 16 Feb. 1823. He received his first instruction in his art at Dijon under Desvoges and in 1782 he took himself to Rome and formed his style on that of the 16th century masters, especially Correggio. He returned to Paris in 1769 and painted portraits, gaining with difficulty his living under the Terror. He gradually made himself known, although his misfortunes had been early aggravated by a marriage undertaken under circumstances of great imprudence; and in 1800 he became famous by his timely picture 'Truth Descending from Heaven.' In 1808 appeared in the Salon his 'Psyche Carried off by Zephyrus' and 'Crime Pursued by Justice and Divine Vengeance.' From this time his position was assured. His importance in the history of French art history lies in the fact that he indicated a revolt from the cold classicalism of David, introduced freer and bolder pictorial effects than had so far obtained in French art, and utilized the emotional and sentimental resources which lie in the skilful distribution of light and shade in a picture. Consult: Clement, 'Prudhon, sa Vie et ses Œuvres' (1880); Gauthiez, 'Pierre Paul Prudhon' (1886).

Prue and I, a work by George William Curtis, first published in 1856. It is a series of sketches or meditations showing the enjoyment to be derived from even the most commonplace existence. The papers are supposed to be written by an old bookkeeper, who strolls down the street at dinner-time, and without envy watches the diners-out. But whatever the genial old bookkeeper is thinking or relating, his heart is full of his Prue, and from beginning to end it is always "Prue and I."

Prune, the dried fruit of certain varieties of plums, extensively cultivated in the Danubian principalities, France, and Italy, in Europe, and in recent years introduced into California, Oregon, and Washington, in the United States; a product of great commercial importance and nutritious qualities. Any variety of plum having the requisite percentage of sugar, plenty of solids and, when cured, will keep for a long time without deterioration, is suitable for making prunes. France produces annually 80,000,000 pounds of prunes of deservedly high reputation for size, perfect curing, and attractive manner of packing.

Prune growing was introduced into California in 1856, from scions imported from France, and in 1863 prunes were for the first time publicly exhibited as a California product. The first large orchard was planted in 1870, yet in 1903 the number of trees in the State was estimated at 2,000,000. Attempts have been made to cultivate the prune in other parts of the United States, but without success, owing to the absence of requisite conditions for curing. Cultivation has been successfully extended to Australia and South America, and these countries will ultimately prove formidable competitors in the trade. In California where the wet and dry seasons are absolutely defined, and from May until October rains are infrequent, never exceeding a fraction of an inch in volume, exist the best natural conditions for perfect curing of the prune. The fruit is not picked until perfectly ripe. It is then passed through a grader which separates the different sizes in order to secure uniformity in drying, as small fruit will dry in a shorter time than a larger grade. Next it is dipped into a weak solution of boiling lye to take off the bloom and facilitate curing. Sometimes the outer skin is punctured by needles so that the surplus moisture in the fruit may more readily escape. In large establishments an endless-chain machine is employed in dipping, but where it is done by hand, a wire dipper is used; and the fruit is again washed in fresh water after the process to clean off the lye. After spreading upon wire-netting trays, the fruit is taken to the field and exposed to the sun's heat until properly cured. The summer days in California are invariably hot, and the green fruit, after exposure to the sun's rays for 6 to 10 days, depending upon size, is thoroughly dried. (In eastern Europe it is customary to cook the green fruit partly before exposing it to the sun.) In countries where periods of dry weather are liable to be interrupted, evaporators are used in extracting the moisture of the fruit, the trays being introduced into a chamber in which the temperature is raised to 140° to 180°, and where they remain from 12 to 48 hours. To understand the exact amount of time necessary to perfectly cure the fruit is essential, as if this matter is ill-judged an inferior quality of product results. When sufficiently cured, the fruit is taken from the trays to bins, where it is allowed to "sweat" for two or three weeks, after which it is ready to be regraded and marketed. Grades are indicated by the number of prunes to the pound, according to the size; 30 to 40 to the pound represents the highest grade, whence the size falls to 120 or 130, the smallest. Before final packing the prunes are "processed" by dipping into a hot solution of water with glycerine or fruit syrup, which not only adds to the beauty and polish of the fruit, but extirpates insect germs that may be present. Producers seldom introduce a substance in the process mixture for increasing weight. In shipping, sacks are employed when a buyer intends to pack for his own trade, but the larger quantity is packed into boxes of stated dimensions at the place of shipment. French methods are also practised in packing higher grades in fancy boxes with attractive linings. In quantity the States of California, Oregon, and Washington produce a larger amount than all foreign countries put together, the annual output of the three States aggregating fully 200,000,000 pounds. Large quantities of the better sort of American fruit are imported into Europe, where they rank equally with the finest brands of France.

Orchards of large size are found in various parts of California. They require careful cultivation (see PLUM), and frequent pruning, besides occasional irrigation. The nomenclature of the prune-making plum is large and abounds in synonyms. The following varieties are most favored in the Western States: Green Gage, Yellow Egg, German Prune, Hungarian, Robe de Sargeant, Bulgarian, Tragedy, Golden Champion, Willamette, Pacific, Tenant, Steptoe, St. Martins Quesche, Brignolle, Dalle de Hongrie, Giant, and others. Consult: Bailey, 'Cyclopedia of American Horticulture,' titles 'Prune'; 'Plum'; 'California'; and 'Evaporation of Fruits' (New York 1900–2).

ENOS BROWN.

Prunel'la, a kind of woolen stuff of which clergymen's gowns were once made, and which is still used for the uppers of ladies' boots and shoes.

Pruning, the removal of parts of plants in order to economize and divert energy in desired directions. Fundamentally the various objects for which plants are pruned are: (1) training, in which the limbs are started and disposed as desired; (2) pruning proper; (3) trimming or the shaping to some artificial form. The first is of prime importance in the early years of orchard fruits, but is of smaller and smaller application as the subjects dealt with are shorter-lived or less tree-like. The second is important, as a rule, during the whole life of the plant, in many cases, especially of trees commencing when the plants are set. The third is usually of small importance, at least in America, being employed mainly with such ornamental subjects as hedges, topiary specimens, and dwarf trees.

Popular opinion concerning the practice has changed within recent years. Formerly it was against pruning upon the ground that the plants suffered, and that the practice was unnatural. But nature is an inexorable pruner, as the straight limbless trunks of forest trees, and the dead twigs and branches of trees left to themselves sufficiently show. The horticulturist improves upon nature in doing his work intelligently, not only with respect to what shall be removed, and when, but how it can be best done, so as to enhance the healing of the wound. The practice is essential to successful orchard-fruit culture, and to a greater or less extent with other plants. With woody plants that have been grown in nurseries it is necessary to cut back the tops to approximate a balance between the top and roots which latter have been necessarily reduced in digging. The usual practice in this matter is to remove at least one half of each branch that is to remain, and to cut off all the others. Many orchardists trim off all the limbs, and some leave nothing but a switch or even a stub, claiming that they can then form the head of the tree where they desire, and that the tree more quickly recuperates than if a larger proportion of top is left. Certain it is that in practice the trees untrimmed at transplanting time generally suffer severely.

Among the principal objects sought in the pruning of fruit-trees the following may be mentioned: To divert plant-food from wood production into fruit formation and development of improved specimens; to keep, not to force, the tree in bearing condition, which is secured by regular annual attention and not by intermittent neglect and butchery; to prevent the excessive production of wood which is usually at the expense of fruit production and ordinarily is a sequence of excessive pruning; to keep the tree within manageable limits so as to facilitate cultivation, spraying, and harvesting; and to admit light and air to the tops so that the fruit may be well colored.

Before any pruning is done, however, it is essential to know the exact manner in which the trees or shrubs bear their fruits, for unless this is understood the operator may be working against his own interests and injuring the tree at the same time. For instance, apples and pears bear their fruits upon gnarly twigs called spurs, the plum and cherry usually upon spurs, but sometimes also on the axial growths; the peach bears usually upon the axial growth of the previous season, but also to some extent upon spurs which live only two or three years as a rule; the quince bears upon terminal shoots of the present season; the grape upon shoots of the current season; the raspberry and blackberry usually upon shoots of the previous season, the shoots dying after production; and the currant and gooseberry upon wood one or more years old. Further advantage may be taken of the method of fruit production in preventing the necessity of thinning, the fruit-buds being removed by the cutting out of the fruit-bearing wood.

In the pruning of ornamental subjects the same principles apply. Except for removing straggling, unsightly, or unnecessary growths, the pruning has mainly to do with flower production. Flowering shrubs and trees may be divided into two groups; those which produce their flowers from buds which were matured during the previous season; and those whose buds are developed during the current year. The one rule that will apply to these subjects is: Prune after flowering. If members of the first group are pruned during the winter they will generally suffer severe loss of flower buds; members of the other group, however, should be pruned, preferably, in early spring about the time that growth starts. Properly done and at the right time the production of bloom should be greatly enhanced with each group.

There is considerable difference of opinion as to when subjects should be pruned, but if wounds are properly made; that is, close to the main stem without leaving any stub, and if the large ones are protected from decay during the healing process, they may be pruned at any time, preferably, perhaps, just before the season of most active growth when the object is wood, and after this period if the object is fruit. Trees grown as cordons, espaliers, etc., require the greatest skill, but these practices are largely matters of training and are of rare application in the United States.

Consult: Bailey, 'Cyclopedia of American Horticulture' (New York 1900–2), 'Pruning Book' (New York 1900–2).

Prunus, a genus of shrubs and small fruit-trees of the rose family, about 75 of which are widely distributed, especially in the north temperate zone, and include many leading fruits of the world and many species of ornamental value. They have alternate leaves; solitary or clustered, pink or white flowers which appear usually in spring; and drupaceous fruits containing one hard-stoned seed. The number of varieties and hybrids is legion; they include weeping, double-flowered, variegated-leaved, and diversely colored subjects, besides the host of varieties cultivated for their fruits. Their range of hardiness varies with the species, some being hardy in the cold north and plains States, others tender even at the latitude of New York. The most important members of the genus are treated under their own titles, as ALMOND; APRICOT; CHERRY; NECTARINE; PEACH; PLUM; PRUNE; SLOE.

Pruri'tus, itching, a symptom of various skin diseases. It may occur independently of any structural alteration of the skin, as a neurosis. It may involve the skin of the entire body or be limited to a particular region, such as the anus, scrotum, or vulva. The sensation is described as prickling, burning, or crawling. It is very annoying when slight, and may be so severe as to destroy all sense of comfort. Excitement and overheating, even the warmth of the bed at night, cause at times troublesome exacerbations. The etiology of this affection is frequently obscure. Impaired general health and a neurotic tendency are predisposing causes. Pruritus senilis is a distressing form occurring in advanced age, and is due to degeneration of the skin. Pruritus hiemalis (winter itch) is peculiar to cold weather. Other causes are the change from light to heavy under-clothing; ingestion of certain drugs, as opium; sometimes hepatic and renal disease; and the circulation in the blood of abnormal biliary constituents, as in jaundice, and of other abnormal material in diabetes. Localized pruritus frequently depends upon a venous congestion of the part; thus pruritus ani is invariably aggravated by constipation and obstruction of the portal circulation; and in pruritus vulvæ, uterine engorgement and pregnancy are exciting causes. Worms not infrequently produce itching of the anus and of the nose, the latter being a reflex condition. The almost constant scratching caused by a persistent localized pruritus is likely to produce eczema.

In treatment the general health is to be improved by hygienic measures; sometimes an entire change of diet, scene, etc., is necessary. Internal medication should be left to the physician. Local remedies are palliative, only relieving the discomfort until the cause of the itching is removed. Among the palliatives are carbolic acid, borax, soda, starch, chloroform in powder, liniments, solutions, and ointments.

Prussia (German *Preussen*), a kingdom comprising the greater part of North Germany, and constituting the empire state of Germany (q.v.), its king, by the constitution of 1871, being emperor of Germany. The kingdom extends from lat. 49° 6′ to 55° 35′ N., and lon. 5° 50′ to 22° 15′ E. It is bounded south by Alsace-Lorraine, Bavaria, Saxony, Bohemia, and Austrian Silesia; west by Luxemburg, the Netherlands, and Belgium; north by the North Sea, Denmark and the Baltic; northeast and east by Russia. The length of Prussia is 700 miles from east to west, and breadth 470 miles north to south. It is divided into the following provinces:

PROVINCES	Area Eng. sq. miles	Population
East Prussia (Ostpreussen)	14,284	1,996,626
West Prussia (Westpreussen)	9,859	1,563,658
Berlin, City of	25	1,888,848
Brandenburg	15,382	3,108,554
Pomerania (Pommern)	11,630	1,634,832
Posen	11,186	1,887,275
Silesia (Schlesien)	15,568	4,668,857
Saxony (Sachsen)	9,751	2,832,616
Schleswig-Holstein	7,338	1,387,968
Hanover (Hannover)	14,870	2,590,939
Westphalia (Westfalen)	7,803	3,187,777
Hesse-Nassau	6,062	1,897,981
Rhine (Rheinland)	10,423	5,759,798
Hohenzollern	441	66,780
Total	134,622	34,472,509

The small island of Helgoland transferred by Great Britain to Germany in 1890, belongs to the government of Schleswig-Holstein.

Topography.— Prussia is naturally divided into two great sections, the larger belonging to the great European plain, and the other in the southwest belonging to the German plateau. The eastern provinces form a level district of over 50,000 square miles, intersected by a few inconsiderable hill chains, the highest elevations of which do not exceed 700 feet. The southwestern boundary of Silesia is formed by the Riesengebirge, or Giant Mountains (average elevation 4,100 feet, highest peak, 4,929 feet), and their continuations, the Iser Ridge and the Lusatian Mountains. The northern part of the province of Saxony, which extends from the river Elbe to the Werra, is almost a perfect level, interrupted only by inconsiderable hills and an isolated elevation of 1,086 feet, the Petersberg, near Halle. The southern portion to the southwest of the river Saale is intersected by projecting spurs of the Harz Mountains (highest elevation, the Brocken or Blocksberg, 3,506 feet), and the Thuringian forest (highest elevation the Dolmar, 2,184 feet). The western provinces contain the northwestern group of the mountain system of Germany, its numerous ridges having as many distinct names. The more important are: on the right bank of the Rhine, the Weser Hills, including the picturesque gap known under the name of Porta Westphalica, the Teutoburg Forest (the battle ground of the Germans and Romans), the Rothhaar Hills, the Sauerland Hills, the Seven Mountains (Siebengebirge), and Westerwald (2,000 feet); on the left bank of the Rhine, the Hundsrück (3,000 feet), Hohe Veen, and Eifel (1,600 feet). The Hohenzollern principalities are intersected by the Rauhe Alp. The coast line of Prussia on the Baltic and North seas has a length of over 1,000 miles. The sea being shallow near the coast, and full of shifting sand banks, there are few good harbors; the best are Helgoland, Kiel, Stralsund, Colberg, and Dantzic. Beside the open bays of Bodden, Putziger Wyck, Prorer Wyck, and Tromper Wyck, there are several extensive lagoons or haffs, separated from the open sea by narrow strips of land or strings of islands. Of these lagoons the Great and Little Haff, whose head is formed by the embouchure of the Oder River, the Frisches Haff, which receives the waters of the Nogat River, and the Kurisches Haff, are the most extensive.

Hydrography.— All the river systems of Prussia belong to the basins of the Baltic and North Seas. The principal rivers in the eastern section are the Memel, Vistula with its tributaries the Drewenz, Ossa, Brahe, and Mottlau, Oder with its tributaries the Oppa, Ohlau, Bartsch, Bober, Neisse, and Warta, and Elbe with its tributaries the Saale and Havel with Spree. Independent of these are a number of coast rivers, namely, the Dange, Pregal, Elbing, Leba, Lupow, Stolpe, Wipper, Persante, Rega, Ucker, Ihna, Peene, and Recknitz, nearly all of them navigable for some distance. The western section is watered by parts of the river systems of the Werra, Ems, and Rhine. The Rhine flows through Prussian territory a distance of 185 miles, receiving on the right bank eight tributaries, namely, the Lahn, Wied, Sieg, Wupper, Ruhr, Lippe, Berkel, and Vechte; and on its left bank the Nahe, Moselle, and Ahr. Beside its rivers Prussia has a large number of artificial water courses, the Vistula and Oder being connected by the Bromberg canal, the Oder and Spree by the Müllrose canal, the Havel and Elbe by the Plaue Canal, and the Baltic and North Seas by the Kaiser Wilhelm Canal. Other canals connect small adjacent river systems in the western provinces. Of lakes Prussia contains an immense number, especially in the level northeastern section; but none of them are important either for their extent or as affording facilities for commerce. The largest lake in the province of Prussia, Spirding, covers an area of only 37 square miles. The province of Saxony contains a small salt lake in the vicinity of Halle, the Röblinger See. In the Rhenish province the Laacher Lake, an old crater, nearly 8,000 feet square and over 200 feet deep, fed by 40 springs, is renowned in legendary lore. The total number of lakes covering not less than 200 acres each is 389, and their total area 750 square miles, the aggregate area of all other lakes being 700 square miles. There are large swamps on the lower course of the Ems, Havel, Oder, Warta, and Netz rivers, attempts to drain which have been fairly successful especially in the case of the great Bourtanger Moor since 1870.

Geology.— Tertiary strata prevail over almost the whole of the level portion of Prussia. In the mountainous districts of the eastern and southern parts of the state the loftier summits are composed of granite, gneiss, mica schist, porphyry, diorite, etc. Secondary formations, composed of mountain limestone and the various strata of the Carboniferous system, occur in Silesia, chiefly in two localities in Upper Silesia along the frontiers of Cracow and Russian Poland, and among the mountains in the county of Glatz, and toward the Riesengebirge. Chalk and its accompanying beds occur in many different localities, more especially on the north side of the Harz, and in Silesia, both in its higher districts and on the frontiers of Poland. Prussia has a great variety and abundance of mineral wealth. Of nearly 110,000,000 tons of coal mined in Germany in 1900 Prussia produced almost 102,000,000, and she contributed 34 million tons of lignite to the total amount of 40 million tons for the empire. Her production of iron ore for that year (4¼ million tons) was nearly a quarter of the total for all Germany, and her output of pig-iron (5¾ million tons) was more than two thirds of the production of the whole empire. About a half of the zinc production of the world comes from Prussia, her total for 1900 being 155,760 tons, and most German lead and copper are of Prussian origin. Cobalt, nickel, and other metals are found and worked in smaller quantities, and pyrites is obtained from Westphalia. Other valuable mineral productions are rock-salt and salts of potassium, magnesium, mineral oils, and peat.

Climate.— Within the same ranges of latitude, and at nearly equal heights above the sea-level, the climate of the western is superior to that of the eastern division of the state. The mean annual temperature is about 1 degree higher, the winter is milder, and the summer cooler, and the range of the thermometer is accordingly confined within narrower limits. The fall of rain, however, is greater, averaging 20 inches in the west and only 15 inches in Silesia and the eastern provinces. This, however, cannot be considered a disadvantage, as the larger quantity of the western is by no means in excess, and only tends to make vegetation more luxuriant.

Forestry, etc.— The best afforested districts are Frankfurt, Potsdam, Liegnitz, Marienwerder, Cassel, Königsberg, Oppeln, and Posen. Sylvicultural knowledge and practice have made great strides in recent times. The fisheries form an important source of revenue. For further details, and for *Flora,* and *Fauna,* see GERMANY.

Agriculture, etc.— The system of agriculture generally pursued, though much improved in modern times, it still very defective. The land is much subdivided, especially in the more populous districts, small farms of three and four acres being the most common holding. The soil includes all varieties, from light sands to the most obdurate clays, but has been subdivided into the three classes of wheat land, light loams of middling quality, and sandy or stony land. On the first soil, as its name indicates, wheat is the prevailing crop, and alternates chiefly with hay and beans. Rye and oats are both much more extensively grown and used than wheat; barley is of smaller importance, alike in the area occupied and the annual produce. Like the rest of Germany, Prussia now imports a considerable quantity of wheat and other cereals. Another important crop, the culture of which is more or less extensive in every district, is that of potatoes. Of these a great proportion are consumed by distilleries in the manufacture of a coarse kind of spirit. Beet-root for the production of sugar has for years been a very important crop. Hemp and flax are also extensively cultivated, more especially the former, which furnishes large supplies for the home manufactures, though much has to be imported. Much tobacco is also raised. Oil plants are important objects of culture, particularly linseed, which forms an important article of export from Eastern Prussia, while large exports of clover and other seeds take place from Brandenburg and the Rhenish province. To the latter province the culture of the vine is chiefly confined. The largest space occupied by vineyards is in the governments of Coblenz and Treves. The culture, on a smaller scale, is carried on in the governments of Cologne and Aix-la-Chapelle, and also in Saxony, Brandenburg, Posen, and Silesia. The breeds of domestic animals are being improved, and much has been done by the government, more especially in the case of horses, by the establishment of breeding studs in different localities, and on a general system.

Commerce.— The principal exports of Prussia are grain, flax, hemp, linseed, oil-cake, flour, sugar, timber, cement, linen and linen yarn, spirits, earthenware, chemicals, wool, woolen cloth, hosiery, iron, and zinc; the principal imports, coal and coke, chemicals, cotton and cotton twist, stone and building materials, iron and ironware, petroleum, grain, tea, oil and turpentine, raw hides, wine, herrings, salt, etc. The Zollverein or Customs Union, by giving a free interchange of communication between the different states belonging to it, makes it difficult to specify the exact amount of trade which each state possesses, but there cannot be a doubt that that of Prussia is very extensive.

Manufactures.— These have made great progress, and are generally diffused over all the provinces. Certain localities, however, form distinctive manufacturing centres, such as the large towns, the valleys of the Rhine basin, the districts of Aix-la-Chapelle, Düsseldorf, Arnsberg, the south of Hanover, southwest Saxony, Lusatia, etc. Manufacturing industries (including the building trades) give employment to over 12,000,000 persons. The chief textile manufactures are those of linens, cottons, and woolens. Silesia, Brandenburg, and Westphalia are the provinces in which the linen industry is chiefly developed. The cotton manufacture has its chief seat on the Rhine, particularly in the neighborhood of Düsseldorf and Elberfeld-Barmen, but is also carried on to a considerable extent in Westphalia and Hanover, in Silesia, particularly in the government of Breslau, and also in the province of Brandenburg. The woolen manufacture has its chief seats in Brandenburg and the Rhenish province. Silk and velvet are made in the Rhine Valley, as also at Berlin. The number of persons employed in the textile industries is about 430,000. The manufactures in metal employ over 500,000 persons. In iron and steel ware the first place belongs to the Rhine province and the Westphalian government of Arnsberg. Among particular localities may be specified Essen, for the celebrated steel works of Krupp, where gigantic cannon are made; Solingen for its fine saws and tools; Aix-la-Chapelle and Burtscheid, Altena and Iserlohn for needles and pins; Remscheid and Hagen for locks and various similar kinds of hardware. Berlin has long been famed for its fine castings, many of which, whether as articles of ornament or utility, are unsurpassed. In connection with these may be mentioned type-founding, which, as well as printing, forms an important branch of industry in Berlin. The leather manufacture is important, and includes, besides ordinary leather, the finer varieties and parchment. Pottery in all its varieties forms an important industry. For porcelain and the finer kinds of ware Berlin and St. Martin, near Treves, are the most celebrated localities; excellent stoneware of a more common description is made extensively in the south of the province of Saxony, in Liegnitz, and in the Rhenish province. Common pottery is made in all the provinces, more especially in those of the east and centre. One of its most celebrated localities is Bunzlau. Glass does not rank high as a Prussian manufacture. The principal localities are the governments of Treves, Minden, and Oppeln. The most important paper-mills are in Silesia, Saxony, and Westphalia. Other manufactures carried on to such an extent as to be of national importance, are beet-root sugar, chocolate, chicory, chemical products, and tobacco. Of these the first is very important, being carried on chiefly in the provinces of Saxony, Hanover, and Silesia. The tobacco industry is also important, and is carried on in extensive factories in the Rhenish province, in Brandenburg and Saxony. The last manufactures deserving of notice are beer and spirits, the consumption of which is immense. The greatest number of distilleries is in the Rhine province, though Silesia has also a very large number. Of the breweries the Rhine province has above one fourth. Sparkling wines are made near Coblenz and elsewhere.

Communications.— Both from the nature of the country and the number of navigable streams which intersect it, Prussia has great natural facilities, which have been greatly extended by roads, canals, and railways. Prussia had, on

April 1901, 19,088 English miles of railway belonging to or administered by the state, and 1,436 miles owned and administered by private companies, making a total of 20,524 miles. The whole of the railways of Prussia will eventually become national property. The principal ports of Prussia are Memel, Pillau, Königsberg, Dantzic, Colberg, Swinemünde, Stettin, Wolgast, Stralsund, Kiel, and Flensburg on the Baltic; and Altona, Hamburg, Geestemünde, Leer, and Emden on the North Sea. The merchant navy of Prussia in 1900 consisted of 2,074 vessels of 270,304 tons register, of which 513, of 191,412 tons register, were steamers. Among the foreign vessels which trade to Prussian ports the tonnage of Great Britain is about one third more than that of any other nation. The second place is occupied by the Dutch, and the third by the Danes. In some of the ports shipbuilding is carried on with activity. Stettin builds about one third of the whole.

Coins, Weights, and Measures. See GERMANY.

Government.— Prussia is a monarchy hereditary in the male line, and from the absence of recognized constitutional checks was, previously to the European revolutionary movement in 1848, in theory absolute. The present constitution was mostly framed by the government, with the aid of the constituent assembly, in 1849, and proclaimed 31 Jan. 1850. It has been modified by royal decrees, of which no fewer than 16 were issued between April 1851 and May 1888. The sovereignty at present belongs to the house of Hohenzollern. The king, whose functions are both executive and legislative, attains majority at the age of 18. He is assisted by a council of ministers appointed by royal decree. A representative assembly composed of two chambers shares the legislative authority with the king. The consent of the king and of both chambers is necessary to all laws. Financial projects and estimates are first submitted to the lower chamber, and must either be accepted without amendment or rejected by the higher. Each branch of the legislature has the right of proposing laws. The upper chamber or House of Lords (Herrenhaus) is composed of princes of the blood of the reigning and former sovereign families of full age; about 100 heads of noble families, and over 200 other members, comprising great functionaries of the kingdom, representatives of towns, corporations, and universities, etc., nominated for life by the king. The second chamber or House of Deputies (Haus der Abgeordneten), since the enlargement of the kingdom, consists of 433 members. The primary qualification of electors is based on taxation, and is the same as for municipal elections. The primary electors are divided into three classes, according to the amount of their taxation. The first division consists of those who pay the highest taxation, the second who pay the medium, and the third of those who pay the lowest amounts; and the numbers in each division are determined by the total amount of taxation, which is equally distributed between the three divisions. The indirect electors (Urwähler) elect the direct electors (Wahlmänner), who choose the representatives. The deputies are chosen for three years, and the new members must be elected within six months of the dissolution of the chamber. The chambers are regularly convoked each November. Members accepting office must be re-elected. Members of the second chamber receive 20 marks ($5) a day, acceptance of which is obligatory. A legal majority of members must be present when a resolution is decided on.

Prussia is represented in the Imperial Bundesrath by 17 members and in the Imperial Reichstag by 236.

Finance.— The estimates of public revenue and expenditure submitted by the government to the chambers are now always made to balance each other, but the actual expenditure has in recent years usually been under the revenue, and sometimes there has been a very considerable surplus. The revenue and expenditure for the year 1901–2 were each estimated at an amount equal to $662,250,000. The total debt by the budget of 1901–2 was $1,650,950,000. A certain part of the debt has been incurred for the construction of railways, and is a profit-bearing investment. The state railways yield a very considerable proportion of the total annual revenue.

Ethnology.— The greater part of the people are Germans, but in several quarters the Lithuanian and Slavonian stocks preponderate. In the northeast corner of the monarchy, between the Deine, Angerap, Goldapp, Pregel, and the Inster and Memel, Lithuanian is spoken, read, written, and taught. The Slavs, chiefly Poles, Czechs, and Wends, occupy the south parts of Gumbinnen, Königsberg, and Marienwerder, the greater part of Posen, and no inconsiderable part of Silesia. French are found chiefly in the west part of the monarchy, but partly also in the province of Brandenburg, where they are descendants of the French Protestants who found an asylum here from the tyranny of Louis XIV.

Population.— As given in the table of provinces the population in 1900 was 34,479,509, of whom 16,971,425 were males, and 17,501,084 females, or 103.12 females per 100 males. The average density of the population is about 256 to the English square mile. The Rhine province (Rheinland) is the most densely peopled, while Pomerania and East Prussia have the smallest population per square mile. Almost every province showed an increase in 1900 over the population of 1895, the only exception being East Prussia. The urban population in 1895 was 12,954,591, showing an increase since 1890 at the rate of 1.84 per cent per annum. The increase in the rural population was only .89 per cent per annum. Berlin is the capital and the largest city, others being Breslau, Cologne, Frankfort, Hanover, Magdeburg, and Düsseldorf.

For *Education, Religion, Judiciary,* and *Local Government,* see GERMANY.

History.— The kingdom of Prussia, which, in the second half of the 19th century, and before the re-formation of the German Empire, possessed the most powerful organization and wielded the greatest and most compact military strength of any state in Europe, dates only from the beginning of the 18th century. The antecedent history of the growth of this state into a kingdom is divided, by the natural order of the circumstances from which it is derived, into two branches. The more important of these follows the rise of the Electorate of Brandenburg, which formed the nucleus of the future kingdom, and contained the principle of unity and the germs of vital organization which directed its growth. The other and less important branch relates to the province of Prussia, which incidentally gave its name to the kingdom, and which in one direction determined its external relations.

During the southern migration of the Teutonic races on the decline of the Roman Empire, the northern part of Germany as far west as the Elbe, and including the modern Brandenburg, was occupied by people of Slavic race. When the divided empire of Charlemagne made way in the 9th century for a German kingdom, military marches (q.v.) were established for the defense of the frontiers. Brandenburg, which had been conquered by Charlemagne in 789, was erected into a margraviate by Henry I. (the Fowler), king of Germany, in 926. Otto I. founded the bishoprics of Brandenburg and Havelburg. Albert the Bear, who received Brandenburg as a fief from the Emperor Lothair (1134), conquered the Slavonian Wends, and took in 1157 the title of Margrave of Brandenburg.) He also held the dignity of archchamberlain of the empire, which conferred the electoral dignity. He began the colonization of the country with German immigrants, which was continued under his successors. His dynasty continued to bear rule till 1320, and during this period German civilization was gradually extended in Pomerania, Saxony, Brandenburg, and Silesia. After its extinction there followed a period of anarchy. Brandenburg fell as a lapsed fief to the empire, and Louis of Bavaria gave it to his son. It continued in the Bavarian house for three successive electorates or reigns, and during this period it was named as one of the principalities to which the electorate was restricted by the Golden Bull (1356). It was subsequently ceded to the house of Luxemburg, and Charles IV., the first imperial representative of this house, gave it successively to his sons Wenceslas (1373) and Sigismund (1378). Sigismund sold the New March to the Teutonic knights in 1402, and twice mortgaged the Electoral March for his debts. On the second occasion, after he had become emperor, he received from Frederick, the burgrave of Nuremberg, a loan of 400,000 gold florins, for which the latter held Brandenburg in pawn for some years. The emperor then formally agreed to cede the electorate in liquidation of his debt, and Frederick, to whom the exchange was acceptable, was duly invested in it at the Diet of Constance in 1417, two years after John Huss had been burned by the decree of the council assembled at the same place.

The burgrave who had acquired the electoral dignity in this manner was the descendant of Conrad of Hohenzollern, a cadet of a Swabian house, who had received in 1200 the appointment of imperial burgrave of Nuremberg, which had become hereditary in his family. The elder branch of the family continued to hold a small territory surrounding the ancestral castle of Hohenzollern, of which they traced their lordship back to the time of Charlemagne, till 1851, when they ceded it to Prussia, and were recognized as princes of the blood.

The territory which Frederick had acquired had relapsed under its imperial rulers into a condition of disorder and lawlessness. The feudal nobility had made themselves nearly independent and had covered the country with their strongholds, which were little better than the abodes of robbers. Frederick protected the towns from their depredations, and gradually reduced their castles. Before his purchase of the electorate he had acquired two small territories in Franconia, Ansbach and Baireuth, the consequent union of which with the kingdom of Prussia subsequently gave rise to important events. Frederick divided his possessions among his sons; the second, Frederick, succeeded to the electorate, and subsequently reunited the territories belonging to it. Frederick II., who succeeded his father in 1440, and who was surnamed the Irontoothed, in honor of his military prowess, extended the possessions of his family by policy as well as by valor. He repurchased the New March from the Teutonic knights, to whom it had been sold by the Emperor Sigismund. In 1470 he abdicated in favor of his brother Albert III., surnamed Achilles, who, by a family ordinance (Hausgesetz), prepared the way in an important respect for the future greatness of his house. Albert resigned the active administration of the government to his son John Cicero in 1476. He died in 1486. John I. was succeeded in 1499 by his son Joachim I., who reduced the last strongholds of his recalcitrant nobility. He founded the first university in the electorate, that of Frankfort-on-Oder, in 1506; and he established a supreme legal tribunal (Kammergericht) at Berlin. He zealously opposed the Reformation, which during his reign spread rapidly in his dominions. In 1510 he expelled the Jews from his territory. His son Joachim II., who succeeded in 1535, embraced the Reformation, and established Lutheranism in 1539. Joachim acquired the title of Hector from the valor he displayed in the Turkish campaigns as imperial generalissimo. In 1537 he signed with Duke Frederick of Liegnitz a hereditary union (Erbverbrüderung), by which the reversion of the principalities of Liegnitz, Brieg and Wohlau was secured to the Hohenzollern house. The Seven Years' war (q.v.) and the acquisition of Silesia by Frederick II. of Prussia were the ultimate results of this agreement. He also acquired a title to the duchy of Prussia. John George succeeded in 1571. He administered his states with a view to relieve them of financial embarrassments entailed by the profuse expenditure of his father. By welcoming the Dutch, who were driven from their country by persecution, he contributed to the industrial prosperity of his country. Joachim Frederick, who succeeded in 1598, married (1603) his son John Sigismund to the daughter of Frederick Albert, duke of Prussia. He effected in 1603 with his cousin George Frederick of Ansbach, on the basis of the Hausgesetz of 1477, the House-treaty of Gera, which was afterward considered the fundamental law of the family. He was succeeded in 1608 by John Sigismund, who united the duchy of Prussia to the electorate in 1618, and brought Brandenburg into contact with Poland (q.v.).

About the same time John William, duke of Juliers, Clèves, and Berg, Count of La Marck and Ravensberg, and Lord of Ravenstein, died without issue in 1609. Among numerous claimants to the succession, in virtue of his wife, was

John Sigismund. By the Treaty of Xanten (1614) Clèves, La Marck, the Ravensberg, being half the succession, were assigned to Brandenburg. Thus was laid the foundation of the Rhine province, which brought the future kingdom in contact with France. John Sigismund again changed the religion of his state by renouncing the Lutheran for the Calvinistic confession. He was succeeded in 1619 by his son George William. That terrible crisis in the affairs of Germany, the Thirty Years' war (q.v.), had now arrived, when owing to the vacillation of its ruler whole tracts of country were depopulated, agriculture was neglected, and trade and commerce abandoned.

Frederick William, son of the preceding, surnamed the Great Elector, and who may be regarded as the virtual founder of the Prussian monarchy, averted the progress of calamity, and soon gave a prosperous turn to the affairs of the state. So wise, prudent, and vigorous was the government of this prince that at his death in 1688 he left a well-filled exchequer, and a fairly-equipped army of 38,000 men; while the electorate, which now possessed a population of one and a half million and an area of 43,000 square miles, had been raised by his genius to the rank of a great European power. His successors Frederick I. (q.v.; 1688–1713) and Frederick William I. (1730–40) each in his own way increased the power and credit of Prussia, which had been in 1701 raised to the rank of a kingdom. The latter monarch was distinguished for his rigid economy of the public money and an extraordinary penchant for tall soldiers, and left to his son Frederick II. (q.v.), Frederick the Great, a compact and prosperous state, a well-disciplined army, and a sum of nearly nine million thalers in his treasury. Frederick II. (1740–86) dextrously availed himself of the extraordinary advantages of his position to raise Prussia to the rank of one of the great political powers of Europe. Frederick was not over-scrupulous in his means of enlarging his dominions, as he proved by sharing in the first partition of Poland in 1772, when he obtained as his portion nearly all West Prussia and several other districts in East Prussia. His nephew and successor, Frederick William II. (1786–97), aggrandized his kingdom by the second and third partitions of Poland in 1793 and 1795. Frederick William III. (1797–1840) succeeded his father in 1797, at a time of extreme difficulty, when continental rulers had no choice beyond being the opponents, the tools, or the victims of French republican ambition. By endeavoring to maintain a neutral attitude Prussia lost her political importance, and gained no real friends, but many covert enemies. But the calamities which this line of policy brought upon Prussia roused Frederick William from his apathy, and, with energy, perseverance, and self-denial worthy of all praise, he devoted himself, with his great minister Stein, seconded by Count Hardenberg, to the reorganization of the state. In the years 1806–10 Prussia underwent a complete domestic reorganization; and after the battle of Waterloo, which restored to Prussia much of the territory lost at the peace of Tilsit in 1807, the career of progress was continued. A tendency to over-legislation, however, became the predominating evil feature of Prussian administration; and the state, without regard to the incongruous elements of which it was composed, was divided and subdivided into governmental departments, which, in their turn, under some head or other, brought every individual act under governmental supervision, to the utter annihilation of political independence. The people soon perceived that this administrative machinery made no provision for political and civil liberty, and demanded of the king the fulfilment of the promise he had given in 1815 of establishing a representative constitution for the whole kingdom. This demand was not acceded to, and its immediate fruits were strenuous efforts on his part to check the spirit of liberalism. The accession of Frederick William IV. (1840–61) seemed to open a better prospect to the friends of constitutional freedom. A political amnesty was proclaimed, religious toleration was announced, and a contest betwixt the crown and the pope, in which the first signs of the coming Kulturkampf (q.v.) may be traced, was brought to a close by concessions on the part of the king. Frederick William, however, was an enthusiastic upholder of the divine right of kings, and it soon became apparent that he was in no way prepared to follow up his vague promises of political liberty by sharing political power with the people. The bureaucratic spirit of over-governing became daily more and more irksome to the nation, and it was evident that a constitutional struggle was inevitable. The king and his advisers, underrating the importance of the movement of 1848 in Germany, thought they had satisfied the requirements of the hour by granting a few unimportant reforms and by making equivocal promises of future concessions. A collision betwixt the troops and the citizens of Berlin, in which blood was shed, awoke the king to the full gravity of the crisis, and he hastened to allay the general discontent by the nomination of a liberal ministry, the recognition of a civic guard, and the summoning of a representative chamber to discuss the proposed constitution. The conversion of the monarch to liberalism was but temporary; and although, after much obstruction, a constitution, superseding the old Prussian estates by a representative parliament, was promulgated in January 1850, it was repeatedly modified in the following years, until few of its democratic features were left. Frederick William had early distinguished himself and delighted many Germans, both within and without Prussia, by his patriotic utterances in favor of a new united Germany. He was deeply chagrined when in 1848 the national assembly at Frankfort, influenced by Austrian jealousy of the military strength of Prussia, declined to accept him as the national leader, and elected instead the Archduke John of Austria as lieutenant-general of Germany. Yet, when in the following year he was offered the imperial crown, he found himself unable to face the responsibility of accepting it. He hesitated to make so important a move in the contest with Austria for the hegemony of Germany. Among the affairs taken cognizance of by the Frankfort assembly was a revolt of the duchies of Schleswig and Holstein against Denmark, which was alleged to have violated their constitutional privileges as German states. The king of Prussia intervened in this quarrel at the instance of the Germanic Confederation in 1848–9. After some severe fighting a treaty of peace was concluded on 2 July 1850, by which the right of Denmark to the duchies was acknowledged, while Holstein was recognized as a member of the Germanic Bund or Confederation. The duchies revolted against this settlement, and the matter was referred, at the instance of the Emperor Nicholas, to the great powers. By the Treaty of London, 8 May 1852, Prince Christian of Schleswig-Holstein, afterward Christian IX. of Denmark, was recognized as heir to the Danish crown, the integrity of the Danish monarchy was recognized, but the rights of the Germanic Confederation over Holstein and Lauenburg as members of the Bund were reserved. The later years of this reign were characterized by great advances in the material prosperity and internal improvement of the country, and especially in the expansion of the Prussian and North German Zollverein (q.v.). William I. (1861–88), who became German emperor in 1871, had been regent of the kingdom since 1858, owing to the illness of his brother, the late king. William was no more a lover of constitutional, or at least of popular, liberty than any of his predecessors; and in his opposition to the progress of the popular movement, in so far as it aimed at interference with the regal power, he was powerfully aided by his great adviser Bismarck (q.v.), who became prime minister in 1862 and imperial chancellor in 1871. For the successful wars with Austria (1866) and France (1870–1), which so enhanced the prestige of Prussia and which resulted in the united Germany of to-day, see Germany; Franco-German War. Since the king of Prussia became German emperor the history of Prussia has been practically merged in the history of Germany.

Consult: Hillebrand, 'La Prusse contemporaine et ses Institutions' (1867); Ranke, 'Memoirs of the House of Brandenburg and History of Prussia' (1849); Tuttle, 'History of Prussia' (1884–96).

Prussia, East, or **Ostpreussen,** ōst-proĭs'-sĕn, the northeasternmost province of Prussia, Germany. Area 14,284 square miles; pop. (1900) 1,996,626. Capital, Königsberg. See Prussia.

Prussia, West, or **Westpreussen,** vĕst-prois'sĕn, a northeastern province of Prussia, Germany. Area 9,859 square miles; pop. (1900) 1,563,658. Capital, Dantzic. See Prussia.

Prussian Blue. See Dyes.

Prussian Brown, a color obtained by adding a solution of the yellow prussiate of potash to a solution of sulphate of copper, which throws down a precipitate of deep brown. This, when washed and dried, is equal to madder, and possesses greater permanency.

Prussian Orders and Decorations. See Orders, Royal.

Prussic Acid. See Hydrocyanic Acid.

Pruten'ic, in astronomy, a term applied to certain tables published by Rimbold in the 16th century, founded on the principles of Copernicus.

Pruth, prooth (Ger. proot), a river of Europe, which rises on the eastern side of the Carpathian Mountains, in the southeast of Galicia; flows circuitously east, then south-southeast, forming the boundary between Rumania and Bessarabia, and after a course of more than 500 miles enters the Danube on the left, about 12 miles below Galatz. On the bank of Pruth, near Husi, in 1711, the army of Peter the Great was surrounded by the Turks, and the Czar was not allowed his freedom until he ceded Azov to Turkey.

Prutz, proots, **Hans,** German historian: b. Jena, Germany, 20 May 1843. He was educated in Jena and in Berlin and became privat-docent at the latter place in 1873. He was engaged in a government expedition into Syria in 1874, and in 1876 accepted a chair at the University of Königsberg, from which he resigned in 1902. Among his principal works are: 'Heinrich der Löwe' (1865); 'Aus Phönicien' (1876); 'Kulturgeschichte der Kreuzzüge' (1883); 'Aus des grossen Kurfürsten letzten Jahren' (1897); 'Preussische Geschichte' (1899–1901); etc.

Prutz, Robert Eduard, German poet and historian: b. Stettin, Prussia, 30 May 1816; d. there 21 June 1872. He was educated at Berlin, Breslau, and Halle, and edited, with Arnold Ruge, a radical periodical 'Hallesche Jahrbücher,' designed to promote more liberal views in science, politics, and religion. In 1849 he became professor of literature at Halle, but soon resigned to devote himself exclusively to science and literature. His poetry is of the patriotic order, as are also his dramas; his novels display keen powers of satire, and his researches as a historian gave him high rank in that field of literature. He was editor in 1851–66 of the 'Deutsches Museum' and his works include, in verse, 'Gedichte' (1849); 'Herbstrosen' (1865); the dramas, 'Moritz von Sachsen'; and 'Erich der Bauernkönig'; 'Der Göttinger Dichterbund' (1841); 'Vorlesungen über die Geschichte des deutchen Theaters' (1847); numerous novels, etc.

Pryce, Richard, English novelist: b. Boulogne, France, 14 May 1864. Among his fictions, several of which have been re-issued in this country, are: 'The Ugly Story of Miss Wetherby' (1889); 'A Just Impediment' (1890); 'Miss Maxwell's Affections' (1891); 'Elementary Jane' (1897); 'Jezebel' (1900).

Prynne, prĭn, **Hester,** the principal character in Nathaniel Hawthorne's romance, 'The Scarlet Letter' (1850). For her sin with the young minister, Arthur Dimmesdale, she was condemned to stand holding her child upon the platform of the pillory in the sight of the populace, and wear a scarlet letter A embroidered upon her bodice. This badge of her shame was worn thereafter, while she did expiation by deeds of mercy among her townspeople.

Prynne, William, English author and politician: b. Swanswick, Somerset, 1600; d. London 24 Oct. 1669. He was graduated at Oriel College, Oxford, in 1621 and admitted to the bar in 1628. He early became a militant Puritan, wrote pamphlets against Arminianism and the frivolities of the age, and in 1632 published a huge volume, entitled 'Histriomastix, the Players' Scourge,' further devoted to assaults on theatres, court masques, cards, and music. Passages alleged to reflect on the king and queen brought down on him savage punishment. He was prosecuted by the Star Chamber and underwent sentence which included the payment of a £5,000 fine, expulsion from Lincoln's Inn and loss of his degree, having his work burned by the hangman, the loss of his ears, exposure in the pillory, and imprisonment in the Tower. Unbroken in spirit he issued tracts from prison, one of which he facetiously entitled ‘News from Ipswich,’ against Archbishop Laud and other prelates, calling them, among other names, «Luciferian lord bishops, execrable traitors, devouring wolves.» The Star Chamber, in consequence, ordered what remained of his ears again cut off, fined him another £5,000 and had the letters S. L. (seditious libeler) branded on both his cheeks. He remained in prison,— still vigorously writing, though, because of a stricter guard, not for the public,— till 1640. He was then released by the House of Commons, was awarded damages and made a triumphal entry into London. Later he was member of Parliament for Newport in Cornwall, and took part in the prosecution of Laud, but was expelled by Cromwell in 1648 for opposition to the extreme measures leading to the execution of the king. He now published such virulent articles against Cromwell that he was twice imprisoned. In 1660, after Cromwell's death, he again sat in Parliament, and upon the Restoration was made keeper of the record. Pamphleteering again brought him into trouble with the House of Commons, but he recanted; and busied himself with the collection of Parliamentary records. He produced more than 200 volumes, of which the most valuable are: ‘Collection of Records’ and ‘Calendar of Parliamentary Writs.’

Pryor, prī'ôr, **Roger Atkinson,** American soldier and lawyer: b. Dinwiddie County, Va., 19 July 1828. He was educated at Hampden-Sidney College and the University of Virginia; was special minister to Greece, under President Pierce; sat in Congress 1859–61 and in the Confederate Congress in 1862. He entered the Confederate army in 1861; was brevetted brigadier-general in 1863; and after the war settled in New York as a lawyer, held various judicial posts, and from 1894 to 1899 was justice of the State supreme court.

Prytane'um, the building in the capital of a Greek state possessing similar features to the town-hall of modern communities, but having in addition a religious significance, and devoted to purposes peculiar to the Greek state. It was dedicated to Vesta and contained the perpetual fire of the state hearth. At Athens the state here entertained its foreign ambassadors, its envoys returned from a public mission, its distinguished generals, victors in the Panhellenic games, and citizens who had done important service to the state. In the latter case the privilege lasted for the life-time of the recipient.

Przemysl, pzhĕm'ĭsl, Austria, a town in Galicia, on the river San, 51 miles west of Lemberg. It is strongly fortified, being a place of strategic importance. It has an active trade and thriving industries. Przemysl was founded in the 8th century by the Polish prince Przemyslaw, and called after his name. The ruins of the ancient residential castle are on a neighboring hill.

Psalmanazar, săl-mạ-nā'zėr, **George** («THE FORMOSAN»), French literary impostor: b. probably in Languedoc, France, about 1679; d. London, England, 3 May 1763. He was educated by the Jesuits, led a vagrant life in France, and finally attracted the attention of Innes, chaplain of a Scottish regiment at Sluys, Holland, who apparently converted him to Protestantism and took him to England, where he was presented to Bishop Compton and others as a native of Formosa. Whether Innes was duped by Psalmanazar or was an accomplice is uncertain, but the supposed Formosan was treated with great honors, encouraged to write ‘A History and Description of the Island of Formosa off the Coast of China’ (1704), translated parts of the English Catechism into the pretended Formosan language, and later was sent to Oxford. He repented of his imposture, however, confessed his duplicity, and devoted himself to study. He became a fine Oriental scholar and led a much respected life in London. He wrote an ‘Essay on Miracles’; several volumes of the ‘Universal History’; and completed Palmer's ‘History of Printing.’ Consult autobiographical ‘Memoir of George Psalmanazar’ (1764).

Psalmody, săl'mō-dĭ or sä'mō-dĭ, a singing of the Psalms of Scripture in metrical versions to simple tunes. Psalms and hymns were sung in the religious assemblies of the early Christians; and the psalms of Scripture form the bulk of the daily religious service or «Divine office» of the Catholic Church, the custom having been borrowed from the synagogue and the temple of Jerusalem. After the Reformation in the 16th century psalmody was greatly encouraged in the Protestant churches of Germany, France, and the Low Countries, and most of the psalm melodies now sung in churches were composed or adapted by German musicians of the 16th century. Metrical versions of the Psalms were made in German, French and English. Marot's French metrical psalms for a while displaced profane music in fashionable society at Paris: Bishop Jewell, describing (1560) the effect of the psalm-singing after the sermons at Saint Paul's Cross by congregations of as many as 6,000 persons, says «It makes the mass priests and the devil sick» (*sacrificos et diabolum ægre habet*). The Scotch reformers paid great attention to psalmody: in John Knox's psalter the Sternhold and Hopkins metrical English version of the psalms was arranged with four-part harmony. The metrical version now used in Scotland is the one made by Francis Rous during the Commonwealth and approved by the General Assembly of the Scottish Church.

Psalms, säms, **Book of,** the Old Testament book which was the hymn book of the Hebrew nation. Most of the psalms were not written specifically for the temple worship, but the whole collection was used for that purpose. The English name, Psalms, came through the Vulgate from the Septuagint name (psalmoi). The common Hebrew name for the book means Book of Praises.

Divisions.— A division of the book of Psalms, at least as old as the Septuagint translation, is into five collections, called books. The books are: Psalms i.–xli.; xlii.–lxxii.; lxxiii.–lxxxix.; xc.–cvi., and cvii.–cl. The English versions, as well as the Hebrew, the Septuagint, the Peshitta, and the Vulgate, reckon the number of the psalms as one hundred and fifty, although the Septuagint gives an additional one which it declares to be «outside the number.» But the Septuagint unites Psalms ix. and x. and cxiv. and cxv. of the Hebrew, and divides cxvi. and cxlvii. The Peshitta partly follows the Septuagint, uniting cxiv. and cxv., and dividing cxlvii. Most English versions follow the Hebrew, but the Septuagint is followed by the Vulgate, the Roman Catholic versions, and some old English versions.

Poetical Form.— The poetry of most of the psalms is lyric, although in a few it is didactic. The form is usually simple. The most elaborate are those having the alphabetic or acrostic structure, in which the separate lines, or verses, or two successive verses, begin in Hebrew with the successive letters of the alphabet. These are Psalms ix., x., xxv., xxxiv., xxxvii., cxi., cxii., cxix., and cxlv. Psalm cxix., however, is distinguished by being divided into sections of eight verses, each verse in a section beginning with the same letter.

Titles.— Most of the psalms have titles, which are of five different kinds, many psalms having more than one. The first class indicates the particular character of the poem. The second gives musical directions, such as the name of the melody to which the psalm was to be chanted. The third is liturgical, indicating, for example, the occasion on which the psalm was to be used. The fourth indicates, according to the usual interpretation, the authorship of the psalms. The titles indicating authorship assign one psalm (xc.) to Moses; seventy-three to David; two (lxxii. and cxxvii.) to Solomon; twelve to Asaph; eleven to the sons of Korah; one (lxxxviii.) to Heman the Ezrachite; and one (lxxxix.) to Ethan the Ezrachite. Thirty-four have no designation of authorship, and are called by the Jews «orphans.» The fifth class gives the historical occasion of the composition, and is found prefixed to thirteen psalms, all of which are attributed to David.

Age and Value of Titles.—The liturgical titles seem to have been added after the exile, while the indications are that the musical directions are pre-exilic. The age and value of the titles indicating authorship are much disputed. One view is that they are in every case historically accurate, having been added at or near the time of writing. Another is that, though they were added some time after the writing, they yet rest upon tradition, which is accurate in many cases, but not in all. A third view is that they were added much later, and represent simply the conjecture of a later time, being therefore all, or nearly all, inaccurate. It is to be noted that the contents of the particular psalms are in some cases inconsistent with the designations of authorship. But in many cases there is no such inconsistency. For this and other reasons the second view above indicated seems the most likely. The titles of occasion are in most cases inconsistent with the contents, and hence are probably later and of less value. It should be added that some eminent authorities have thought that the Hebrew phrase rendered «of David,» does not denote authorship, but should be rendered «belonging to David,» in which «David» was the name of an earlier collection of psalms, some of which were Davidic. This view is possible, but less natural than the one above indicated.

Davidic Psalms.— How many psalms David wrote, is a question on which there is much difference of opinion. The old view was that he wrote the seventy-three attributed to him by the titles, and also the thirty-four that are anonymous. At the present time it is sometimes held that he wrote all, or nearly all, assigned to him by the titles. Many, however, maintain that he wrote none; and some assign to him various numbers, from three to forty. The conception of the character of David and of the age in which he lived is not affected so much by the number of Davidic psalms, as by the decision whether any are from him. In fact, one prominent argument with those who deny entirely the Davidic authorship is based upon the claim that the historical books represent David simply as a bloodthirsty freebooter, which claim, however, is not borne out by the facts. It may be regarded as probable that David wrote approximately forty of those assigned him by the titles.

Maccabean Psalms.— The question of Maccabean psalms has an importance second only to that of Davidic psalms. Many modern writers hold that all or nearly all of the psalms were written in connection with the Maccabean struggle in the second century B.C. Some in modern as well as ancient times attribute a few to that period; while others deny that any were written so late. The chief direct argument for Maccabean psalms is that some harmonize well with the historical conditions of that time, an argument which is perhaps strongest with lxxiv. and lxxix. Further, the circumstances of the time were naturally such as to stimulate the production of religious poetry. Some general considerations, however, are unfavorable to a belief in Maccabean psalms. None are mentioned in the history of the time. Again, it is probable that the Old Testament books had already been collected and formed into the threefold division, the law, the prophets, and the writings, in the time of the Maccabees. It is not probable that many new productions would be added after that. Also, the Septuagint translation of the psalms, if not made before the Maccabean period, probably dates from a time only a few years after, and the Septuagint translators found unintelligible the musical titles of some psalms often attributed to this period, such as lx. and lxxx. It seems improbable, therefore, that any psalms are Maccabean.

Age of Division into Books.— Each of the five books of the psalms has a heading, and each of the first four has at its close a doxology, namely, Psalm xli., 13; lxxii., 18–19; lxxxix., 52; and cvi., 48. All these doxologies markedly resemble each other, and have no connection with the psalms to which they are attached. They were evidently added as concluding doxologies to the books, and are not a part of the individual psalms. It is probable that Psalm cl. was intended to serve a similar purpose as an extended concluding doxology for the last book and for the whole psalter as well. The doxology at the end of the fourth book is included in 1 Chronicles xvi. 36, as a part of a longer quotation. This indicates the existence of this doxology, and so of the division into books, at the time of the composition of Chronicles, late in the Persian period. All indications suggest that each book was compiled separately, so that this division existed from the first.

Use of Divine Names.— In the first, fourth, and fifth books the divine name Yahweh is used almost exclusively; while Elohim greatly preponderates in book two. In the first part of book three, Psalms lxxii.–lxxxiii., Elohim has the preference, while the reverse is true of the latter part of the book, Psalms lxxxiv.–lxxxix. But no clear reason appears for this variation in usage.

Distribution of Davidic Psalms.— In book one, all the psalms are ascribed to David except four, which are anonymous; eighteen are ascribed to David in book two; one in book three; two in book four; and fifteen in book five.

Arrangement of Psalms.— It is probable that the present order of the books represents the chronological order of their compilation. Many would hold that all were compiled after the exile. It seems probable, however, that the first book was compiled before the exile; books two and three soon after the exile; and books four and five at about the time of Ezra and Nehemiah. Some have supposed that originally there were only three books, the second and third being later divided, each into two parts. The evidence, however, seems to be against this view. The psalms within each book are not arranged chronologically, nor in such a way as to give a regular progress of thought. The principle of arrangement seems rather to have been to put together psalms which had similarities with each other, in some cases the same author, in others a similarity of thought, but more often than otherwise some external resemblance, such as the use of the same word or phrase.

Unity of Book.— Many of the psalms are the expression of individual feeling and aspiration; some have in mind the circumstances or history of the nation; while others are written with especial reference to worship. Yet in spite of this varied character and of the diversity of authorship substantial unity in thought is found throughout the whole collection.

Teaching concerning God.— The amount and value of the theological teaching of the book of Psalms should not be underestimated. Yet it must be remembered that such teaching is often incidental, in harmony with the usual character of the psalms as lyrical rather than didactic. In the teaching concerning God, it is his power that is most strongly emphasized. The greatness of his power as seen in the wonders of nature and in the creation of man is depicted with poetic fervor. Of his moral attributes, justice receives chief emphasis. This is presented as the ground for expectation that the wicked will be punished, and his servants, the righteous, avenged and rewarded.

Messianic Teaching.— The Messianic teaching in the psalms is much less than has often been thought. It is usually indirect, prophecy concerning a present king containing elements which find their entire fulfilment only in the Messianic king. Such prophecy tells of the world-wide rule of the Messiah. Similar predictions, not directly Messianic, are found in some of the later psalms, which foretell the coming of Yahweh to punish the wicked and bring salvation to the oppressed righteous. This is substantially equivalent to the day of Yahweh of prophetic expectation.

Teaching concerning Man's Relation to God.— The teaching concerning man's relation to God is substantially the same in the psalms as in the prophets. Sacrifice and ritual are alluded to as customary and important. Yet they are not highly esteemed as merely external acts. Obedience, thankfulness, contrition of heart, prayer, are considered as of value in the sight of God rather than sacrifice. The true way to forgiveness is through repentance. Although many psalms are national, yet in the relation to God the importance of the individual is emphasized, more even than in the earlier prophets.

Teaching concerning the Future Life.— Like other parts of the Old Testament, the general teaching concerning the future life in the psalms is indefinite. The shadowy region of Sheol is for the most part the limit of expectation. Yet there are several suggestions of a future condition in which there is a clear separation of the righteous and wicked, with especial emphasis upon the reward of the righteous. In these passages it is taught that the strength of the fellowship with God in the heart of the true believer is such that it can not be interrupted by death, but must continue in the future life.

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Psalter, sâl'tėr, the Book of Psalms (q.v.); also a book containing the Psalms separately printed; also specifically, the version of the Psalms in the English Book of Common Prayer. It is also the name of an ancient string instrument of music, the Hebrew *Kinnor;* called by the Germans Rotta (*Cithara Teutonica*). Sometimes the rosary of 150 beads used by some order of nuns is called the Psalter, as the Psalter contains 150 Psalms.

Psammetichus, sạ-mĕt'ĭ-kŭs (PSAMATIK I.), Egyptian king, first monarch of the 26th (650–527 B.C.) dynasty. He is first heard of as feudal lord of Saïs, the chief centre of the western delta. He formed an alliance with Gyges, king of Lydia, against the suzerain power of Assyria; and by the aid of Carians and Ionian Greeks supplied by Gyges, defeated the Assyrian vassal-kings and was crowned "lord of the two Egypts." Herodotus says he blockaded Azotus (Ashdod) for 20 years; and he may indeed frequently have besieged it. He made Phœnicia a vassal state, and devoted much attention to art and architecture. The demotic (or enchorial) writing which, because of greater facility, superseded the hieratic, was invented during his reign, though it cannot be ascribed to his initiative.

Psara, psä'rä, or **Ipsara** (Gr. *Psyra*), an island of Turkey, in the Grecian Archipelago, seven miles northwest of Scio; about five and a half miles in length, and as many in breadth.

It consists almost entirely of a rock, thinly covered with a vegetable mold. At one time it had considerable commerce, and a population of 30,000.

Pseu'do-Isido'rian Decretals. See DECRETALS.

Pseudolucæmia, sū"dō-lū-sē'mĭ-ạ, or **Hodgkin's Disease,** a disorder of the lymphatic glands and sometimes an affection of the spleen, characterized by anæmia and progressive hyperplasia. It is also attended by secondary lymphatic growth variously distributed in the body. Leucocytosis — excess of white corpuscles in the blood — which accompanies many blood diseases, is not present in pseudolucæmia. See BLOOD.

Pseudomorph, the name applied to a mineral which has replaced another, or which appears in crystal forms which are foreign to its original formation. Massive varieties of minerals are more subject to such changes, but the action is frequently more difficult to trace. There are three kinds: Pseudomorphs, epimorphs, and paramorphs. See also MINERALOGY.

Pseu'donym (Fr. *pseudonyme,* from Gk. *pseudonymos*). A name adopted by an author who desires to remain unknown, or assumed for the purpose of attracting more attention at first than might follow from the use of the author's own name. (See ANONYMOUS.) Consult: Barbier, 'Dictionnaire des Ouvrages anonymes' (1872–9, with supplement 1889); Halkett and Lang, 'Dictionary of the Anonymous and Pseudonymous Literature of Great Britain' (1882–8); Cushing, 'Initials and Pseudonyms' (1885–8).

Pseu'doscope, in optics, an instrument, invented by Wheatstone, for producing an apparent reversion of the relief of an object to which it is directed, by the transposition of the distances of the points which compose it. A false impression is thus conveyed to the eye, a globe becoming apparently concave and a hollow body assuming a convex form. See OPTICS.

Pseudosu'chia, an order of *Crocodilia.* See HERPETOLOGY.

Psilomelane, a hard, dull, black mineral, essentially a hydrous manganese manganate, but part of the manganese usually replaced by barium. It occurs abundantly massive or in botryoidal and stalactitic forms in Germany, England, Arkansas, and many other localities. It is one of the commonest ores of manganese.

Psittaci, sĭt'ạ-sī, the parrot tribe, a family of scansorial birds, comprising over 300 species, of which the genus *Psittacus* is the type. See PARROT.

Pskov, pskŏf, or **Pleskov,** Russia, (1) town, capital of the government, on the right bank of the Velikaya, which here receives the Pleskova, 165 miles south-southwest of Saint Petersburg. It is walled, flanked with towers, all in a very dilapidated state, as are also many of the houses. It consists of the Kremlin, the Central city, the Great city, and a considerable suburb. All the private houses and the far greater part of the public edifices are of wood. The finest buildings are in the Kremlin. The principal manufacture is Russian leather; and there is a considerable trade in hemp, flax, tallow, hides, etc. Pskov is the see of an archbishop, and possesses a theological seminary and a well-managed hospital. It is said to have been founded by the Princess Olga toward the end of the 10th century.

(2) A government of Russia, bounded north by Saint Petersburg, northeast by Novgorod, east by Tver, southeast by Smolensk, south by Vitebsk, west by Livonia; area, 17,069 square miles. The surface toward the southeast is traversed by the Valdaï Hills, but sinks gradually down near the centre, having only a gentle slope toward the north and west. The soil is throughout of poor quality, and can only be made to yield tolerable crops by fertilization. Wheat is seldom grown, and the principal crops are oats and barley, which are raised in considerable quantities, so as to leave a surplus for export. Forests are extensive; but the wood is not of the best quality. The only other manufacture of importance is leather. Pskov is divided into eight districts. Pop. about 1,300,000.

Psoriasis, sō-rī'ạ-sĭs, chronic skin disease, allied to alphus and lepra, non-contagious but often hereditary. It is characterized by an inflammatory condition, with slightly elevated patches, dry and various in number, size, and shape, to which grayish scales adhere. These exfoliate, to be repeatedly renewed. The extensor sides of the extremities, the elbows, knees, trunk, and scalp, become first affected, and the flexor sides of the limbs are afterward attacked. Only the mucous membranes of the body are exempt from this disease, the cause of which is little understood, and which requires for treatment competent medical skill.

Psovie, or **Borzoi.** See GREYHOUND.

Psyche, sī'kē, in Greek mythology, a beautiful maiden regarded as an allegorical personification of the human soul. In a version of her story given by Apuleius in 'The Golden Ass' she is the daughter of a king and far outshines in loveliness her two elder sisters. Men take her for Venus herself and pay her the homage due to the goddess. In anger Venus directs Cupid to inspire Psyche with love for some unworthy wretch, but Cupid himself falls in love with Psyche. Meantime her father consults the oracle of Apollo regarding his daughter's marriage, and is commanded to convey her to the summit of a mountain and there leave her, for she is the destined bride of a monster dragon feared by gods and men. Sorrowfully he obeys, but when Psyche is left alone she is wafted by Zephyr to the palace of Cupid who visits her every night and departs unknown before morning. She is warned by her lover never to seek to know who he is, and no break would have occurred to her happiness had she not allowed her jealous sisters whom she admitted to her confidence to half persuade her that she held a hideous monster in her arms. One night while Cupid slept she came with a lamp to see him and in her astonishment and joy at beholding the most beautiful of the gods she lets fall a drop of heated oil upon his shoulder. Cupid awakes, reproaches Psyche for her suspicions, and leaves her. After trying in vain to drown herself, Psyche wanders from place to place seeking her beloved till she comes to the temple of Venus. Having Psyche at last in her power Venus treats her as a slave and imposes menial tasks, under which the maid would sink but for secret help obtained from Cupid. At length Venus orders Psyche to descend to the realm of shadows and bring away Proserpine's box of cosmetics. She succeeds in the adventure, but on opening the box is assailed by a deadly vapor issuing therefrom and perishes. Cupid now reappears, touches her with an arrow and restores her to life. Venus is reconciled, and Jupiter places Psyche among the immortals. Her marriage to Cupid is celebrated with great festivities, while her envious sisters cast themselves from a precipice. Consult a translation of Apuleius' story in Walter Pater's ‹Marius the Epicurean,› and poetical versions of the tale in Morris' ‹Cupid and Psyche› in ‹The Earthly Paradise›; and Bridges, ‹Eros and Psyche.›

Psychiatry, sī-kī′ạ-trĭ, the study and treatment of mental diseases. The psychiatrist or alienist, whose specialty has greatly developed in recent years, must needs be likewise a pathologist and a neurologist, to make his scientific and clinical equipment adequate to the task of dealing with the various conditions and symptoms usually present in the patients committed to his skill. No clinical work is more delicate and none more strictly required than that of the practitioner in this branch of medical science. See INSANITY.

Psychical Research. In its technical sense psychical research refers to objects and methods of investigation employed by The Society of Psychical Research, which was founded in England in 1882. The function of this society is set forth in the following announcement: «It has been widely felt that the present is an opportune time for making an organized and systematic attempt to investigate that large group of debatable phenomena designated by such terms as mesmeric, psychical and spiritualistic. From the recorded testimony of many competent witnesses, past and present, including observations recently made by scientific men of eminence in various countries, there appears to be, amidst much illusion and deception, an important body of remarkable phenomena, which are *prima facie* inexplicable on any generally recognized hypothesis, and which, if incontestably established, would be of the highest possible value. The task of examining such residual phenomena has often been undertaken by individual effort, but never hitherto by a scientific society organized on a sufficiently broad basis.» The society's membership has included the names of Henry Sidgwick (the first president), A. J. Balfour, W. F. Barrett, Balfour Stewart, Edmund Gurney, Frederic W. H. Myers, Oliver Lodge, William Crookes, Lord Rayleigh and Alfred Russel Wallace. In 1884 an American Society for Psychical Research was established and later (1890) incorporated with the British society. Similar organizations have been formed in Germany and other countries. In 1904 the combined membership of the British and American branches exceeded 1,300 names. The records of the society fill more than twenty volumes of Proceedings and Journals. Besides these official reports, individual members have published numerous works on psychical research. The investigations of the Society have been directed by six principal committees to whom the following tasks were severally assigned in 1882: (1) An examination of the nature and extent of any influence which may be exerted by one mind upon another, apart from any generally recognized mode of perception. (2) The study of hypnosis, trance, clairvoyance and other allied phenomena. (3) A critical revision of Reichenbach's researches with certain organizations called «sensitive.» (4) An investigation into apparitions and haunted houses. (5) An inquiry into the various physical phenomena commonly called spiritualistic; with an attempt to discover their causes and general laws. (6) The collection and collation of existing materials bearing on the history of these subjects. In brief, the work of the committees has covered the subjects of telepathy, hypnosis, trance, automatisms, «magnetic sensations,» apparitions and «spiritualistic manifestations.» Three principal methods have been employed by the committees and by individual members of the Society: (1) the examination of accumulated evidence and of current cases; (2) experimental investigation, and (3) statistical treatment. The first of these methods has been used widely in the study of apparitions and alleged spiritualistic phenomena — ghost-stories have been collected and noted mediums examined; the second, in hypnosis, in tests of Reichenbach's claims, and in the collection of evidence for telepathy; and the third, in interpreting extensive data regarding apparitions and hallucinations.

The results obtained by the several committees are quite unequal. Investigations into the «magnetic sense,» into clairvoyance, haunted houses and the grosser physical manifestations of «spirits»— that is, raps, table-tipping, slate-writing, levitation and «materializations»— have turned out, on the whole, negatively. Many instances of fraud, of defective observation and of involuntary deception have been brought to light. Hypnosis and allied states have been investigated, not so much for their own sake as for the study of telepathy and of subconscious states. The work of the Society may be said to centre in the questions of telepathy and the existence of mind independently of the body. In order to secure evidence touching both these matters the Society for Psychical Research instituted, in the years 1889–92, an extensive census on hallucinations. Answers to the number of 17,000 were returned to the following question: Have you ever, when believing yourself to be completely awake, had a vivid impression of seeing or being touched by a living being or inanimate object, or of hearing a voice; which impression, so far as you could discover, was not due to any external physical cause? About one tenth (1684) of the answers were affirmative, and, of this number 80 were «death-coincidences, that is, cases of recognized apparitions occurring within twelve hours of the death of the person represented, the death being unknown to the percipient at the time.» The committee in charge of the census draws the conclusion that «between deaths and apparitions of the dying person a connection exists which is not due to chance alone.» In the last few years, the Society has devoted much attention to the study of trance states as produced in certain persons called «sensitives.» This study is said to furnish evidence of telepathy. It is considered, by some members of the Society, to be the most fruitful subject for further investigation.

The achievements of psychical research are difficult to estimate. The movement has undoubtedly contributed to knowledge of the facts investigated and the conditions under which these facts arise. It has also performed a service to mankind in its critical examination both into the validity of human testimony and into certain unreliable factors in the motives to the establishment of belief. The evidence offered for a telepathic agency and for the independent existence of mind apart from cerebral functions is considered in some quarters as amounting to proof; in others, as lending probability only to these hypotheses; and, by many educated persons, as entirely lacking in cogency. It is of importance to notice, in this connection, that belief in the factual basis of telepathy — that is, in the influence of one mind upon another where no physical medium has yet been discovered — does not necessarily imply a theory regarding the nature of, and the conditions underlying, such influence. Various hypotheses intended to explain the facts in question have been offered, but no one of them has as yet found general acceptance.

Psychical research, in so far as it examines conscious experience, sustains a somewhat intimate relation to psychology; although it is more closely allied to abnormal than to general psychology. It should be pointed out, however, that its aims, and, in some respects, its methods, also, bring it into closer relation to certain practical aspects of life and to philosophy than to psychology.

Consult: Proceedings of the Society for Psychical Research; Gurney, 'Phantasms of the Living' (1886); Myers, 'Human Personality and Its Survival of Bodily Death' (1903); Parish, 'Hallucinations and Illusions' (1897); Podmore, 'Studies in Psychical Research' (1897).

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Psy'chidæ, a family of moths (q.v.).

Psychological Apparatus. The object of the psychological laboratory is, in brief, to standardize the conditions of introspection (see PSYCHOLOGY); to make it possible that psychological observations shall be taken in the most favorable circumstances, so that they may be repeated (by the same or by other observers), isolated and varied. It is only under these experimental conditions that the results of introspection can lay claim to universal validity. The single, hap-hazard observation, made under all the distractions of ordinary life, is worth as little in psychology as it would be in physics or physiology. Hence it was nothing less than a revolution in psychology when W. Wundt founded in 1879, at Leipsic, the first psychological laboratory that the world had known. Wundt's example was quickly followed in America by G. S. Hall, who founded a laboratory in 1881 at the Johns Hopkins University. At the present time, all the more important seats of learning in Germany and the United States are equipped with psychological laboratories, while there are a large number distributed through the other civilized countries of the world.

To give an idea of the problems with which the experimental psychologist is busied, we may mention some of Wundt's early apparatus and the questions which he hoped to solve by their aid. In 1861 Wundt devised the *complication pendulum* (Fig. 1) in order to determine the behavior of attention under the influence of two simultaneous stimuli. Suppose that I am subjected, at one and the same time, to a sight and a sound. Do I hear and see together? Do I see before I hear, or hear before I see? The question was of great practical importance, since it was involved in the "eye and ear" method then in vogue for a certain type of astronomical observations. Its general psychological importance is obvious. The instrument, now, "consists of a large heavy wooden pendulum. The bulb carries a pointer, which as the pendulum swings passes over a circular scale. Near the point of rotation m there is fixed to the stem a horizontal metal bar ss. A movable vertical standard h has attached to it a metal spring, also in the horizontal line. The spring is fixed in such a way that the bar ss in passing by produces a short single click, the end of the bar and the point of the spring just touching each other, while the shock is so slight that the course of the heavy pendulum is not noticeably affected. By watching the course of the pointer attached to the bulb of the pendulum, while the upper part of the instrument remains concealed, we can determine at what point of its passage to or fro the click of the spring takes place. For example, if the pointer appears to be at e' at the moment of the sound, the bar ss will be in the position ab, and this will mean that the passage is put too early. If the pointer seemed to be at e'', the bar would be in the position cd, and this would mean that the passage was put too late. If we know the duration and amplitude of the pendular vibration, and measure the angular difference between e' or e'' and the actual point at which the bar ss comes in contact with the spring, we can easily calculate the interval between the giving of the sound and its apperception." The instrument has been gradually refined, and its scope extended, until it now has the form shown in Fig. 2.

Another of Wundt's early experiments was made to determine the range of consciousness for auditory impressions. I hear a number of similar sounds; say, of metronome strokes. How large a group can I keep in mind at once? I must not count; for that would mean a separate attention, and a verbal association, to every sound. Suppose that a group of 20 strokes, marked off by bell-tones, is followed by a group of 21, marked off in the same way. Do the two groups appear the same, or can I tell that they are of different lengths? This question was answered by Wundt by aid of the instruments shown in Fig. 3. The metronome M gave the series of sounds, and the limits of the series were indicated by the bell G. Fig. 4 shows a later and better instrument, for the determination of the range of consciousness to visual impressions.

A third experiment concerns our judgment of time intervals. A wheel, driven by clockwork, carries a pointer which clicks against contact strips arranged along the circumference. The instrument is shown in Fig. 5. It is possible to give two clicks, and to let the observer arrest the clock after an interval which seems to him to be equal to the interval that separates the clicks; or to sound three clicks,—two continuous intervals,—and to let the observer judge of the equality or inequality of the times enclosed by them; or, finally, to sound four clicks,—two intervals with a pause between,—and to see how the observer's judgment of equality or inequality of the times varies with variation of this intervening pause. A newer and more elaborate instrument is shown in Fig. 6.

A fourth experiment, known as the «simple reaction experiment,» is important for the psychological analysis of attention and action. A simple stimulus (a flash of light, or the sound of a ball falling on a wooden plate) is given to the observer, and he replies to it by making some simple movement, which has been determined beforehand. Instruments are so arranged that the giving of the stimulus starts an electric clock, and the responsive movement stops it: so that the time elapsing between stimulus and answer to stimulus can be exactly measured. It is clear that the «reaction» experiment reproduces for us, in an elementary form, the consciousness of voluntary action. We see or hear something, and act upon it. Since the experiment can be repeated as often as necessary, it is possible, by means of it, to subject the action consciousness to minute and refined introspective examination. We find, further, that the time of reaction varies, according as the attention is directed predominantly to the stimulus or to the reaction movement, according as the stimulus attended to is to be apprehended in its qualitative or intensive character, according as the observer is fresh or fatigued, etc. The apparatus employed are shown in Fig. 7. The falling of the ball upon the plate in *F* starts the electric clock *H*, whose unit is 1-1000 sec. Pressure of the finger upon the key *U* stops the clock: this pressure constitutes the movement of reaction. *C* is a hammer, whose time of fall is constant; it serves to check the accuracy of the clock (chronoscope). The other instruments figured are subsidiary. Fig. 8 shows an elaborate apparatus for giving visual stimuli in reaction work.

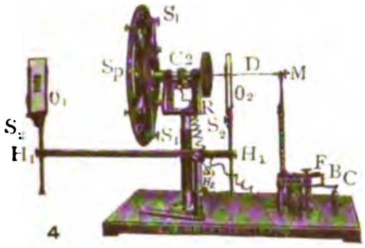
The reaction experiment may be adapted to more complex consciousnesses. Thus the observer may be told that he will hear either a noise or a tone: he is not to move until he is sure of the stimulus given (discrimination reaction). Or he may be told that he will hear either a noise or a tone, and that he is to react to noise with the right and to tone with the left hand (choice reaction). Or again, the stimulus may be a spoken word, to which the observer reacts by speaking a second word which he has associated to the stimulus. Instruments have been devised which meet the requirements of these and of many other variations of the experimental procedure.

The four experiments thus far discussed are typical of the problems with which experimental psychology set out. In a well-equipped modern laboratory, the apparatus fall into three main groups: demonstration instruments, with which experiments may be performed upon the lecturer's desk; class instruments, which are put into the hands of undergraduate students for training and drill-work; and research instruments, the materials of investigation by graduate students and by the instructing staff. As an illustration of the demonstration group, we may cite Wundt's apparatus for negative after-images of vision (Fig. 9). A large circle of colored glass, placed directly behind a ground glass plate, and illuminated by a powerful lamp, is fixated by the members of the class for some 30 seconds. At the end of this time a screen is dropped between colored glass and lamp. The ground glass surface then appears, as a light gray; and upon this gray background the after-image of the colored stimulus develops. As an illustration of the second group, we may mention an apparatus for the determination of the *minimum visibile* of distance (Fig. 10). Two black points appear upon a white cardboard surface. The one point is fixed: it is painted upon the back surface of a sheet of glass which covers the cardboard. The other, painted upon the cardboard background, can be moved to or from the fixed point by means of a micrometer screw (reading to 1-200 mm.) placed at the side of the frame. The problem is to determine the least separation of the points which (under given conditions of experimentation) can still be perceived by the observer. Finally, as an illustration of a recent research instrument, we may refer to the drop-tachistoscope for range of visual attention shown in Fig. 11 (see Fig. 4).

The range of psychological instruments is very wide. In the sphere of sensation, we have apparatus for work on color mixture, contrast, adaptation, after-images, color blindness, and the spatial distribution of the retinal sensitivity; for work on tonal fusion, beats, combination tones; for work on the sensations of pressure, warmth and cold, on the sensations of taste and smell, and on the organic (muscular, articular, etc.) sensations. In the sphere of affection, we have instruments which register exactly the bodily changes that accompany change in the affective disposition (pleasantness and unpleasantness): pulse recorders or sphygmographs, breathing recorders or pneumographs, volume recorders or plethysmographs, and strength recorders, ergographs and dynamographs. In the sphere of attention, we have instruments for measuring the duration and the range or span of the attentive state. In the sphere of perception, we have, for example, all sorts of instruments for the analysis and synthesis of visual space perception: among them the familiar stereoscope, and its converse, the pseudoscope; instruments for the measurement of the various types of optical illusion, and so on. Memory and association have a whole laboratory of apparatus of their own: one of these, which exposes at regular intervals a series of words or syllables to be memorized, is shown in Fig. 12.

It should be clear, even from this hasty and imperfect survey, that the arrangement and furnishing of a modern psychological laboratory is a very complicated matter. There must be a large lecture room, fitted with all conveniences for desk demonstrations and class experiments. There must be a dark room, for work in psychological optics, and an absolutely quiet room, for work in psychological acoustics. There should be a special room, specially ventilated, for work on olfactory sensation and perception. There must be a series of fairly large and well lighted rooms for the group work of undergraduate students. There must be a series of

PSYCHOLOGICAL APPARATUS.



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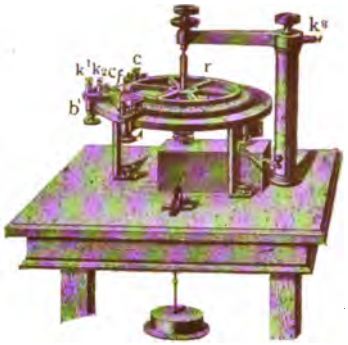

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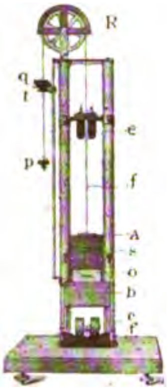

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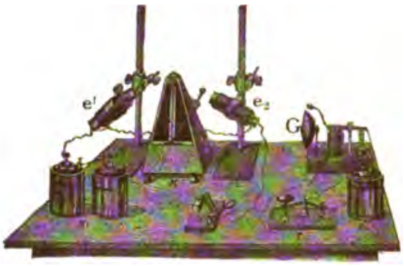

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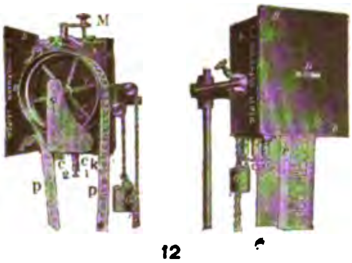

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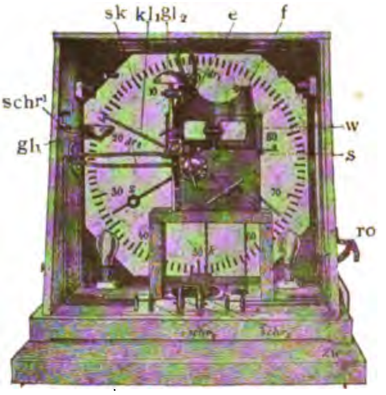

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For explanation see article.

sire, etc. Lastly, we may notice, after a little scrutiny, that these processes in their turn are, literally, concrete: not simple, but made up of simpler elements. My idea of retaliation, for instance, is an idea of something that would take time for its fulfilment, of something that would run its course in stages or phases. And it is more than probable that each one of the stages would, under accurate observation, turn out to be a concretion and not an elementary process.

Now this work of analysis, which we have so far pursued without the aid of any technical method, constitutes the first part of the real problem of psychology. The psychologist is called upon, first of all, to determine the number and nature of the mental elements. Mind, like all other organizations,— like the natural world itself,— is built up from certain irreducible elements; and if we are properly to understand it, we must catalogue and describe its elementary processes. Psychologists are nowadays fairly well agreed that the mental elements are of two kinds or classes: sensations (blue, cold, sour, the tone C, the sensations of pressure on the skin, of muscular contraction, of smell, etc.), the ultimate constituents of the intellectual life, and affections (pleasant, unpleasant), the ultimate constituents of the life of feeling and emotion. There is no simple process underlying the volitional life; all acts of will, all resolutions and choices, are made up of sensations and affections in conjunction. On the other hand, mind is not adequately described as a resultant or derivative of the two elements. It is true that every consciousness, in the last resort, is compounded of so many sensations and a certain affection. But we find that the elementary processes of a consciousness may differ, not only in degree or intensity (as strong and weak, loud and faint), but also in clearness or distinctness. So we may speak of a «state» of consciousness, very much as we speak of the state of the roads, or of the weather, or of a man's affairs. We speak always in terms of the same material: in terms of the road-bed, of rain and shine, of capital and interest. In the case of consciousness, we speak always in terms of the ultimate elements, sensations and affections. Only, as the road may be firm or muddy, the weather clear or threatening, the financial outlook good or bad, so may the processes in consciousness be clear or obscure, distinct or indistinct, powerful and insistent or ineffective, overshadowed by rival processes. It is worth noting that modern psychology thus finds a use for the phrase «state of consciousness» which is altogether different from its use in the older psychology. When consciousness was identified with the «I,» the phenomena that we now call processes of consciousness were naturally identified with the «states» or «manifestations» of the active principle; and even to-day, in popular writing, the phrase «states of consciousness» is oftentimes employed with the meaning of «conscious processes.» Such confusion of language can only minister to confusion of thought. The processes, the materials of consciousness, are one thing; the state or condition in which the materials are presented is another.

The most important states of consciousness, in the normal life, are those of attention and inattention. In attention, the processes that make up a consciousness run their course at two different levels. The processes attended to are more clear and distinct, sometimes are stronger and last longer than their fellows; the processes attended-from are depressed, checked, obscured. In inattention, all the processes run at the same low level.

Analysis, then, the first part of the problem of psychology, leaves us with the two elementary processes, sensation and affection, and with the elementary states of attention and inattention. The psychologist is next required to bring the results of his analysis together, to make a synthesis, to formulate laws of the connection of the elements. The synthesis is tested, at every step, by appeal to introspection, that is, to the actual facts of mental experience. If the analysis has been faulty, the reconstruction will be faulty, will not square with the facts; the method thus becomes its own test of truth. Proceeding in this way, psychology is able to rise to laws or uniformities; it states the laws of color mixture, the laws of affective sequence and composition, the limits of the grasp and duration of attention. Proceeding still further along the same road, it states the laws of the association of ideas, or of the expression of the emotions. In time, it becomes quantitative, and gives numerical formulæ for the intensity of a color contrast or the trustworthiness of memory. In doing all this, it is simply following the example of the sciences of nature, organizing and systematizing its material.

If, now, psychology went no farther, it would still have claims to rank as a science. But it would be a merely descriptive, not an explanatory science. As a matter of fact, it goes on to explain its phenomena, to give the conditions under which they occur or appear. And at this point we come upon one of those theoretical differences of which we spoke above. What are the conditions of a mental process? Some psychologists affirm that, as the mind is always found together with a living body, so it is always conditioned upon physiological processes; a mental formation or concretion is to be explained by reference to the bodily condition that underlies it. Others, again, make appeal to unconscious or subliminal mental processes, which are the condition of our conscious experience, of the supraliminal mind. And yet others would explain mind by mind, deriving mental process from mental process by a principle of mental causality. We cannot decide between these suggestions; limits of space forbid us even to give an adequate account of them. It may be said, however, that the second is the least satisfactory of the three, while controversy is keenly concerned about the other two. The experimental psychologists tend, perhaps, rather toward the first than the last.

The Method of Psychology.— The special method of psychology is experimental introspection. Two questions arise with regard to it. Is introspective observation ever really valid? And is the experimental method adequate to the whole mind, or only to its simpler processes?

It has been objected that introspection can never yield valid results, for the simple reason that it interferes with the course of consciousness. If consciousness is made up of mental processes, then introspection itself is a process or a group of processes. Hence, whenever I set out to observe a given complex, I introduce into consciousness (by the mere fact of observation) another complex, which must clash with the object of my observation. But that is a poor method which interferes with the very thing which it purports to examine and describe! The objection is usually met by the rule that one must wait to observe a mental process until after it has completed its passage; that introspective examination must always be a *post mortem* examination. On this rule, every introspection would involve memory, and be subject to the errors to which memory is subject; though the memory is in play so soon after the event to be remembered that these errors may be considered minimal. In reality, both the objection and its answer seem to beg the question of what introspection is. What the psychologist does, when he introspects, is to experience attentively, to live attentively, the process under investigation, and to make a report about his experience in words. No new process is introduced into consciousness. Whether the words that describe the experience are uttered as the process runs its course, or are pronounced after it is over, will depend upon the circumstances of observation and upon the psychologist's ability and training: no single rule can be laid down in the matter. As thus understood, there can be no question but that introspection is a valid form of scientific observation. And even apart from this theoretical justification, introspection is justified by its results.

The second question, that of the scope of experiment in psychology, has been much discussed, and with very different results. If we face it in the light of history, it seems to answer itself. Psychologists were told, at first, that they could not push the borders of experiment beyond sensation. But they invaded the spheres of affection and attention. They were then told that experiment was adequate only to the simplest states and processes of mind. But they experimented upon perception and idea, upon association and memory and imagination. They were told, again, that experiment could never attain to the purely intellectual, or indeed to any of the higher aspects of the human mind. But they made experiments upon judgment and reasoning, and upon the æsthetic consciousness. It is true that these latter experiments are few and scattered, and that whole consciousnesses still await experimental investigation. But there seems to be no doubt that, in principle, the entire realm of mind is susceptible to experiment. With a method thus justified, it can only be a matter of time for psychology to establish herself as securely as physics or physiology.

The Various Departments of Psychology.— Many attempts have been made to classify the different departments of psychology in accordance with some logical plan. As no such classification has received general acceptance, we may ourselves abandon the attempt to be logical, and simply pass in brief review the most important branches of psychology that exist at the present time.

We may distinguish, at the outset, an analytical from a genetic psychology. Defining roughly, we may say that analytical psychology takes the human mind as it is, and aims to distribute its elements and laws, while genetic psychology seeks to trace the growth of mind from its first beginnings, and to explain the present in the light of mental history. It is needless to say that the two psychologies overlap at many points. Analysis can seldom be completed, except by help of genetic considerations; and the study of psychogenesis implies, on its side, an analytical knowledge of the developed mind. Genetic psychology is also termed comparative psychology, and has various subdivisions: animal psychology, child psychology, the psychology of adolescence, etc.

We may distinguish, secondly, between qualitative and quantitative standpoints within psychology. Suppose, for example, that I am interested to determine the least difference between two weights that can be perceived by the lifting hand. The numerical result that I obtain is a quantitative result in analytical psychology. If, however, I attempt to trace out the various conscious factors that contribute to my judgment of difference or no-difference,— factors of expectation, of habit, of fatigue, of attention, that may affect the judgment; factors of attentive comparison, of association, of first impression, of effort or ease, that may directly prompt the judgment,— then I am performing a qualitative experiment. The two sorts of result should always go side by side, and should (in a perfect psychology) run exactly parallel, — a numerical statement accompanying the introduction of every qualitative term. Both are indispensable to complete knowledge. Genetic psychology is, at present, almost entirely qualitative, and will probably remain so for a considerable period. It is but the other day that statistical methods were introduced into the study of organic evolution.

We may distinguish, once more, between psychology as a science of mental function and psychology as a science of mental structure. The difference is very much like that which obtains between anatomy and physiology. Structural psychology seeks to discover what consciousness is composed of, when the organism is functioning in a certain way. I remember, or I recognize, or I imagine. What, then, are the constituent processes of the memory consciousness? What is my mind made up of, when I am recognizing? What actually takes place, mentally, when I imagine? Many interesting facts have been brought to light by structural psychology. Thus it has been shown that, when we recognize an object, we ordinarily do so, not by way of a comparison of the perceived thing with its memory image, but simply by way of a diffused "feeling of familiarity," consisting essentially of those organic (internal) sensations which enter into the bodily attitude of relief or freedom from tension. Functional psychology seeks, in its turn, to classify and derive the functions of consciousness, the uses to which mind is put in the service of the organism. Thus it may reduce the root-functions of mind to those of cognition and interest, and trace the differentiation of the former into discrimination, integration, comparison, etc., and that of the latter into the manifold modes of conative (will) and emotive consciousness.

All these psychologies are, in one sense of the term, individual psychologies; they discuss the composition or genesis of a single, typical mind. There is, however, a specific, individual, or differential psychology, whose problem it is to trace the correlation between the processes or functions characteristic of a certain type of mind, and to compare this with other minds of different types. Thus it is a fact of individual psychology, in this sense, that some minds depend mainly upon visual, others again upon auditory, and still others upon kinæsthetic (motor) images in the processes of memory, imagination, and thought. Over against individual psychology, in this meaning of the word, stands national or racial psychology, which attempts to discover the forms of thought and feeling characteristic of the common mind of a people.

This common mind is, indeed, a fertile field for psychological cultivation. The mind of a people is, from one point of view, nothing more than the aggregate of the minds of the individuals composing the people. There are no new processes in the common mind: common mental processes are impossibilities. From another point of view, however, the common mind offers a distinct problem to psychology. The mental productions of men in society differ from the mental productions of the individual. No single man would ever have invented language in order to talk with himself; language is a product of the common mind. One mind may take on a habit; it requires at least two to make a law or a custom. These products of the common mind — mythology, and religious observances, language, law, and custom — are treated by social psychology, which approaches them by analytic, comparative, and genetic methods, and seeks to explain them in part from the nature of the individual mind, in part from the circumstances in which man, as a social being, has at various epochs of his history been placed.

Lastly, we may contrast normal with abnormal psychology. This deals with such transitory abnormalities as sleep and hypnosis, or with the chronic derangements of insanity. In every case, the key to the abnormal mind is to be found in the status of attention. In dreams, we have a limited and irregular distribution of attention; in hypnosis, an exaggerated passive attention, with its accompanying suggestibility. And we have misdirection, inertia and decay of attention variously exhibited in the various forms of mental disorder.

Here our list of the principal departments of psychology may come to an end.* All through, introspection is the special psychological method, and the dictum of introspection is the final appeal. Animals and infants and the insane cannot, of course, be called upon to introspect. Nor, for that matter, can a «common» mind. But we observe the conduct of children and animals, and interpret it in the light of our own adult introspections; we search for parallels to the abnormal in our own normal consciousnesses; and we base our study of social psychology upon the laws of the individual mind.

Mind and Body.— The question of the relation of mind to body is an old one in the history of philosophy; but it is a question that still awaits its answer. Psychology cannot avoid it; and we may therefore give here a brief indication of current views.

The two rival theories now most in vogue among systematic psychologists are those of psychophysical parallelism and of interaction. The former declares that mental and bodily processes run side by side, without mutual influence or interference. Every mental process is paralleled by a nervous process. But the nervous processes are links in the unbroken chain of physical causation; and this is complete in itself. Mind is wholly unable to work changes in matter. The latter theory affirms, on the contrary, that mental process influences and is in turn influenced by bodily process: our grief makes us cry, our idea that it is late makes us run to catch a train, as truly as our fit of indigestion makes us gloomy, or a cold in the head makes us stupid.

Common sense is, naturally enough, on the side of interaction. Nevertheless, the theory presents grave difficulties. We must either admit that mind is a special mode of energy, capable of give-and-take with the various forms of energy familiar to us in the natural world; or we must assume that the mind can, without expenditure of energy, deflect the course of physical molecules. Parallelism, while it sins against common sense by making mind causally inefficient, epiphenomenal, has at least the advantage that it leaves the order of the natural universe intact. It has, indeed, further advantages. It has proved to be an admirable working hypothesis for scientific psychology; and it is a purely empirical and non-committal statement of the relationship of mind and body,— a statement that may be reconciled with diverse forms of philosophical belief. It leads, perhaps, most directly to the philosophical doctrine of panpsychism, according to which consciousness is the reality and the concomitant brain-process a phenomenal symbol of this reality. This doctrine serves to reconcile the conflict between parallelism and interactionism, seeing that it guarantees the efficiency of mind while it insists upon the parallel relation of mind and body. It may be noted that Gustav Theodor Fechner (1801–87), the father and founder of experimental psychology, combined an acceptance of psychophysical parallelism, as a working hypothesis for the laboratory, with a belief in panpsychism as the only tenable metaphysics.

The Relation of Psychology to Other Sciences and to Philosophy.— Psychology comes into manifold relation with the natural sciences. As a quantitative science, it requires the aid of mathematics; as an experimental science, it requires the aid of physics. In all its forms, it presupposes a knowledge of the physiology of sense-organs and nervous system: if it seek its explanations in physiology, this knowledge must be accurate and detailed. Insanity can be understood only in the light of pathological histology; comparative psychology rests upon comparative anatomy and comparative physiology.

Nor is the relation less close with the «mental sciences.» Social psychology comes into contact with anthropology and ethnology; with political history and sociology; with philology; with the history of art, religion, law,— the history of civilization at large. It is, indeed, hardly too much to claim for psychology the central position in the classification of the sciences: a position that connects it equally with the sciences of nature, on the one hand, and the sciences of the productions of the human mind on the other.

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* "Experimental psychology" is simply psychology approached by the experimental method; it is not a special branch of psychology. "Physiological psychology" is a phrase used sometimes as an equivalent of experimental psychology, sometimes as an inclusive term, covering (besides experimental psychology) a portion of the physiology of the central nervous system.

The relation of psychology to philosophy is less easily defined. Until very recently, psychology was not a science at all, but a branch of philosophy. Now that her independence is established, psychology naturally tends to emphasize the breach between herself and the philosophical disciplines. Philosophy, on the other hand, unwilling to recognize the independence of a revolted subject, insists that psychology runs into danger as soon as ever she rejects metaphysical guidance. There is truth in both attitudes. One may be a good psychologist, at the present day, without having opened a philosophical book. Contrariwise, one cannot approach the fundamental questions that lie before and after psychology without plunging, at once, into problems of epistemology and of metaphysics. As with life and matter, so with mind: there is practical work to the done in physics and biology and psychology that may be done, and well done, without philosophical reference. But the practical work springs out of, and leads toward, theoretical issues of the widest kind.

It may be added that the central position of psychology is further warranted by its relation to the special departments of philosophy. Functional psychology is the necessary basis of logic; social psychology is the only straight path to a sound ethics; a psychological analysis of the sentiment of beauty is the prerequisite of æsthetics; the psychology of the religious consciousness is the propædeutic to a philosophy of religion.

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Psy″chophys′ics. By some this science is regarded as synonymous with physiological psychology; by others, as dealing particularly with the phenomena which bring out the relation of sensations to physical stimuli. In this character it deals with the study of Fechner's and Weber's laws as a separate department of psychological science. Psychophysics deals particularly with the measurements of intensity of sensations, and endeavors to establish general laws regarding the phenomena. Consult: Wundt, ‘Physiologische Psychologie’; Baldwin, ‘Dictionary of Philosophy.’

Psychrom′eter, an instrument for measuring the tension of aqueous vapor in the atmosphere. See HYGROMETER.

Ptah, ptä, or **Phtha**, Egyptian god of the most ancient type, described in inscriptions as “creator of the earth, father of the gods and all the beings of this earth, father of beginnings.” He was compared by the Greeks to Hephæstus, being, like him, patron of metal-workers and sculptors. Representing the beginning of all things he was shown as an undeveloped child or dwarf (Ptah-Patack), or as a mummy. He had a magnificent temple at Memphis.

Ptarmigan, tär′mĭ-gan, a grouse of the genus *Lagopus*, which differs from the ordinary grouse in having the legs feathered to the claws, giving somewhat the appearance of a hare's foot (whence the generic name). The truncated tail has 14 or 16 feathers, most of the species become white in winter, and the nasal groove is densely clothed with feathers. There are six or eight species described, inhabiting the northern and snow-covered regions of both hemispheres, being one of the few genera characteristic of the arctic fauna; they are as much at home in snow as are the web-footed birds in water, and their plumed feet enable them to run over its surface without sinking in. They live in families during most of the year, and are monogamous; the females incubate, but the males assist in rearing and feeding the young. The males have a loud harsh or sometimes clear cry, and the females cackle like a hen. They fly swiftly without a whirring noise, and run well. They feed upon berries, buds, mosses, and lichens, and insects. Their pursuit affords an exciting sport; they are very shy, but when started are easily shot on account of their regular flight. The summer plumage is varied with brown, black, and gray, most of the wing remaining white; in the males the mottling is finer and the colors brighter. There are three well ascertained species in America, besides several sub-species and races. The white ptarmigan or willow grouse (*L. lagopus*) is about 16 inches long and 24½ inches in alar extent; the bill is black, very stout, and convex, and broad at the tip; the general plumage in summer is rufous or orange chestnut on the head and neck; feathers of back black, closely barred with yellowish brown and chestnut; most of wings and lower parts white; tail brownish black; in winter white, with black tail; no black stripe through the eye. It occurs commonly in the northern parts of America, and in rare instances in the northern United States (Maine and Minnesota). It is found in open rocky grounds and among dwarf willows and birches. In winter they scratch in the snow down to the mosses and lichens on which they feed, collecting often in considerable flocks. In winter the flesh is dry, but is tender and with an agreeable aromatic flavor in summer. They breed in Labrador about the beginning of June, placing the nest under the creeping branches of low firs; the eggs are from 6 to 14, of a fawn color or rufous ground with irregular spots of reddish brown; only one brood is raised in a season. The rock ptarmigan (*L. rupestris*) is 14½ inches long; the bill is slender, rather compressed at the tip; in summer the feathers of the back are black banded with yellowish brown and tipped with white; in winter white, with the tail black (the four middle feathers white), and the male with a black bar from the bill through the eyes. It occurs in arctic America, from Alaska to Labrador and the Gulf of Saint Lawrence. The white-tailed ptarmigan (*L. leucurus*) is found on the alpine summits of the Rocky and Cascade Mountains from New Mexico to the Arctic Regions. This species is entirely white in winter; and in summer the tail, wings, and lower parts of the breast are white, the remainder of the plumage being a fine mixture of gray, brown, and black. A fourth species (*L. welchi*) is attributed to Newfoundland. Of the Old World species the red grouse (*L. scoticus*) is peculiar to the British Islands and a famous game bird. Unlike the other members of the genus it does not become white in winter. A typical ptarmigan (*L. alpinus*) is found in northern Europe, especially in Norway. Our own willow grouse, or a closely related species, also occurs. Consult Baird, Brewer, and Ridgway, 'North American Land Birds' (Boston, 1874). See GROUSE.

Pteran'odon. See PTERODACTYLS.

Pteras'pis, a fossil fish. See OSTRACODERMI.

Pterichthys, tĕ-rĭk'thĭs, a genus of extinct fishes belonging to the sub-class *Ostracophori* and considered to be remotely related to the modern lampreys. *Bothriolepis* is a related genus from the upper Devonian formations of America, as well as the Old World. None of the species exceed a few inches in length. The affinities of these strange forms are little understood. See OSTRACODERMI.

Pter'iodophytes. See FERNS AND FERN ALLIES.

Pterodactyls, tĕr-ō-dăk'tĭls, extinct flying reptiles of the Mesozoic group *Pterosauria*. These bird-shaped reptiles are distinguished by the enormous elongation of the fore-limbs into wings, and especially the fifth or outermost finger, which served for the attachment of a membrane, by means of which these animals could support themselves in the air like bats. No outer skeleton of scales, etc., seems to have been developed. The dorsal vertebræ are hollow in front and convex behind, the front ribs of the trunk possessing double heads. The cervical or neck vertebræ were of large size, those of the pelvis being exceedingly small. The breast-bone was broad, and, as in birds, bore a median ridge or keel for the attachment of the pectoral or breast muscles, used in flight. The sternal ribs were ossified. The jaws were elongated, and provided with teeth, set in sockets. The head itself was of relatively large size. The eye was protected and strengthened by possessing a row of bony plates in its outer or sclerotic coat. The bones of the shoulder-girdle consisted of a shoulder-blade or scapula, and of large coracoid bones, which, as in birds, were attached directly to the breast-bone. No collar-bones or clavicles appear to have been developed. The bones of the fore-arm were elongated, the outermost finger being excessively developed in this respect, and clawless, while the other digits were furnished with claw-like nails. The elongated finger gave support to a wing-membrane, which extended along the sides of the body to the comparatively small and weak hind limbs, and also stretched between the hind limbs and short tail. The bones were hollow, as in birds.

The Pterodactyls are exclusively confined to the Mesozoic rocks, being found from the Lower Lias to the Middle Cretaceous rocks inclusive. The lithographic slates of Solenhofen in Bavaria, belonging to the Upper Oolitic system, are especially rich in pterodactyl remains. Most of them are of small or moderate size. Familiar species, among many, are the *P. crassirostris, P. longirostris, P. longicollis, P. brevirostris, P. medius*, etc. Other genera are *Dimorphodon*, which possesses large, sharp, front teeth, and small, lancet-shaped hinder teeth; *Ramphorhynchus*, which has no teeth in the front portion of either jaw, but possesses hinder teeth in both jaws. The front portion of the jaws in the latter form may therefore have formed a bird-like beak. *Pteranodon*, however, has no teeth at all, and has been made the basis of a separate group (*Pteranodontes*). One of its species (*P. longiceps*) from the Middle Cretaceous of Kansas had a wing expanse of 20 feet. Consult: Zittel-Eastman, 'Text-book of Paleontology' (1902); Seeley, 'Dragons of the Air' (1902).

Pterop'oda, a group of mollusks, formerly regarded as a distinct class, but now known to be only a sub-order of the opisthobranch gastropods, especially modified for a pelagic life. Like the other opisthobranchs, they are simple in structure, the heart being posterior in position and the nervous system without a trust. They are hermaphroditic. The name pteropod refers to the ring-like development of lateral processes (parapodia) of the foot, which serve as fins by means of which the animals swim. The head and usually the tentacles and eyes are lacking. Some of the species are naked, while others secrete delicate shells, which are in some cases spiral (*Limacinidæ*), or straight slender cones (*Carolinidæ*) or more or less pyramidal (*Hyaleidæ*). All of the species are small, many being almost microscopic in size. In certain parts of the ocean these animals are so abundant that their dead shells, accumulating on the bottom, have given the name "pteropod ooze" to the deposits. In the northern seas one species (*Clione papilionacea*) occurs in enormous numbers, forming a large element in the "brit" on which the right whales feed. Fossil pteropods are well known from all rocks from the Lower Cambrian to the present. Consult authorities cited under MOLLUSCA. See OOZE.

Pterosau'ria, a subclass of Mesozoic reptiles, prominently characterized by the power of flight; the pterodactyls. Anatomically, they have fixed quadrate bones, and the anterior limbs formed into wings, with enormously elongated ulnar finger carrying a patagium. The group consists of an order (*Pterosauri*), divided into two suborders *Pterodactyli* and *Pteranodontes*. See PTERODACTYLS.

Pteryg'ium, a fan-shaped patch of mucous membrane on the ocular conjunctiva, its base being usually at the inner angle of the eye (the canthus), its apex at the margin of the cornea or overlapping it. It may appear on the temporal side of the eye; sometimes two of the patches occur in the same eye and cover the whole cornea as with a thick veil, preventing vision. Pterygium occurs in middle and advanced life, and may be either stationary or progressive. In the progressive form the patch is fleshy and the vessels are pronounced; in the non-progressive form it is pale and flat. The ordinary (regular) pterygium is due to irritation of the conjunctiva by dust and minute bodies. It may become inflamed and lead to ulceration of the conjunctiva and cornea and to impaired vision. Irregular pterygium is usually the result of burns or ulcerations. Paronychia is sometimes spoken of as pterygium digiti; pinguicula, a fan-shaped yellowish patch on either side of the cornea in old age, due to irritation from dust, etc., and leading to colloid inflammation, is sometimes called pterygium landaceum or pterygium pingue. Pterygium unguis is a condition in which the epidermis coats the nail with a thin transparent layer. For treatment of pterygium, removal by excision, strangulation, cauterization, or curettement may be employed.

Pterylog'raphy, the description of the arrangement and habit of growth of feathers (*pterylosis*) on the body of a bird. A bird's plumage does not grow evenly from the whole surface of the skin, but in certain tracts (pterylæ), the form, extent, and disposition of which differs in the various orders, families, and genera; so that the pterylosis is a character of importance in classification. The fact that the nearest approach to a uniform clothing of feathers occurs now in the ratite birds, penguins, and the like, which are lowest in organization and of most ancient origin among birds, indicates that pterylosis is a comparatively modern acquisition, and its more striking manifestations occur among birds otherwise referable to a high rank in classification. The principal feather-tracts are similarly disposed in all the groups, and consist of a tract embracing the head; a tract along the spine; a line along each side of the neck, down each side of the breast, and along the side of the abdomen curving inward to meet at the vent; a line lengthwise across the shoulders; two patches upon each leg; and the regions of growth of the wing and tail feathers. The disposition of the powder-down tracts is also a part of pterylography. This matter was first expounded by the German naturalist Nitzsch, author of 'Pterylographie' (Halle, 1847), whose work was translated and extended in a volume of the Ray Society of London for 1867. Consult Newton, 'Dictionary of Birds' (1893-6).

Pterylo'sis. See Pterylography.

Ptolema'ic System, in astronomy, the system by which Claudius Ptolemy tried to explain celestial motions. The earth is the fixed centre of the universe; a vast sphere, the "primum mobile," carries all the celestial bodies, and rotates once a day; the sun and moon travel in eccentric circles round the earth, and this accounts for the annual motion of the sun, and the monthly motion of the moon; each planet moves in a circular path, termed its epicycle, about a point, and this point travels in an eccentric circle round the sun; all motions in each order of circle being described uniformly, this explained the looped paths, the progressions, stations, and retrogradations of the planets. Every new astronomical observation required a new contrivance on this system, and at length the necessary cyclic and epicyclic combinations became excessively cumbrous.

Ptolemais, tŏl-ē-mā'ĭs. See Acre.

Ptolemy, tŏl'ĕ-mĭ (Ptolemaios), the name of a line of Græco-Egyptian kings, who ruled from the death of Alexander the Great till the Roman occupation of Egypt 323-30 B.C. The name Ptolemy, though the common, was not the exclusive name of the kings of this dynasty, and they are better distinguished by the surname Lagidæ, from Ptolemæus Lagus, the founder of the dynasty, also surnamed Soter.

Ptolemy I. (called Soter, "the Saviour"): b. Macedonia; d. 283 B.C. According to Lucian he was born about 367 B.C., but on the supposition of his being a son of Philip it must have been some years later. In 330 B.C. he was admitted into the body-guard, and from this time appears in important transactions. During the Indian campaigns he was regularly employed in the most important commands, and distinguished himself alike for valor and capacity as a general. He continued on terms of intimate friendship with Alexander, and accompanied him in his last campaign 324 B.C. On the death of Alexander he attached himself to the party of Perdiccas, and secured for himself the government of Egypt. He then proceeded to strengthen himself in his government, and concluded a secret league with Antipater against Perdiccas. In the arrangements made after the death of Perdiccas Ptolemy retained Egypt; and subsequently strengthened himself by marrying Eurydice, daughter of Antipater. On the death of Antipater (319 B.C.) Ptolemy united with Cassander and Antigonus against Eumenes, and on the defeat of Eumenes by Antigonus joined Cassander and Lysimachus against Antigonus, who invaded Syria in 315, overran Phœnicia, and laid siege to Tyre, which he took in 314. Cyprus revolted in 313, and Ptolemy proceeded thither in person, and reduced the whole island. In 312 he invaded Palestine. In 311 a general peace was effected, but it was not of long duration and was broken by Ptolemy in 310. In 308 he invaded Greece, but made little progress, and Antigonus now resolved to wrest Cyprus from Ptolemy (307). The Egyptians were totally defeated at Salamis, and Cyprus fell into the hands of the victor, who assumed the title of king. In 305 Ptolemy assisted the Rhodians against Demetrius, and from the Rhodians on this occasion acquired his surname of Soter. In 302 a league was formed against Antigonus, but alarmed by a false report that Antigonus had won the battle of Ipsus he retired to Egypt. The defeat and death of Antigonus in this battle raised Seleucus to a position of great power, and a dispute ensued between him and Ptolemy for the possession of Cœle-Syria and Phœnicia, which were ultimately acquired by Seleucus. In 295 Ptolemy recovered Cyprus, which became a permanent dependency of Egypt. Ptolemy had two sons by Eurydice, but determined to bestow the crown on Ptolemy Philadelphus, a younger son by his favorite wife

Berenice. He announced his own retirement, and caused him to be proclaimed as his successor, 285 B.C. Ptolemy is regarded as the most prudent of the successors of Alexander. His internal administration of Egypt was enlightened and successful. He raised Alexandria to the highest rank in commercial prosperity, and founded in that city a colony of Jews, to whom the special place taken by Alexandria in subsequent times in philosophy and literature, as well as in politics, was in great measure due. He was also an eminent patron of literature, science, and art, and founded the library and museum of Alexandria. He himself wrote a narrative of the wars of Alexander, used as an authority by Arrian.

Ptolemy II. (PHILADELPHUS): b. Cos, 309 B.C.; d. 247. He was raised to the throne during the lifetime of his father Ptolemy I. He concluded a treaty with Rome after the defeat of Pyrrhus, and continued faithful to his alliance during the Carthaginian war. There was a chronic but uneventful war carried on during his reign with Syria. Toward the close of his reign it was terminated by the marriage of Ptolemy's daughter Berenice to Antiochus III. Either by the treaty or in the course of the war Ptolemy acquired Cœle-Syria and Phœnicia. He was also, in general, on hostile terms with Macedonia. But the chief care of Ptolemy was directed to the internal administration of his kingdom and the encouragement of commerce. He founded Arsinoe (on the site of Suez) to protect the navigation of the Red Sea, and Berenice, on the Red Sea coast, and from the latter place formed a road to Coptos on the Nile, by which the commerce of India and Arabia continued for ages to pass to Alexandria. The chief glory of Philadelphus was his munificence as a patron of science and literature. He raised the institutions founded by his father to the highest degree of splendor and spared no pains to fill the library of Alexandria with all the treasures of ancient literature. Among architectural works of merit erected during his reign were the lighthouse on the island of Pharos, the Alexandrian Museum, and the royal burying-place. He founded numerous cities and colonies not only in Egypt, but in Syria and Cilicia. He is supposed to have been the patron of Manetho in his Greek rendering of Egyptian history, and there is a tradition that it was at his instance that the Seventy made their translation of the Old Testament. During his reign the dominion of Egypt extended into Ethiopia, Arabia, and Libya, and embraced the provinces of Phœnicia and Cœle-Syria, besides extensive tracts in Asia Minor and the islands of the Mediterranean.

Ptolemy III. (surnamed EUERGETES), son of Ptolemy II.; d. 222 B.C. He was early engaged in an important war with Antiochus III. of Syria, who had put away his wife Laodice to marry Berenice, daughter of Ptolemy II. On the death of Philadelphus he put away Berenice and restored Laodice. The resentment of Laodice, however, was not appeased, and she sacrificed to her revenge her husband, her rival, and their infant son. To avenge his sister Ptolemy invaded Syria and advanced to the confines of India. Recalled to Egypt by intelligence of seditions there he brought with him the statues of Egyptian gods carried off by Cambyses, which he restored to their respective temples, and thus earned the title of Euergetes (benefactor) from his subjects. The fleets of Ptolemy had at the same time subdued the coasts of Asia Minor, and carried his arms to the Hellespont and to the coast of Thrace. Ptolemy took some part in the affairs of Greece generally, as was the policy of Egypt, against the rulers of Macedonia; maintained friendly relations with Rome, but declined the assistance of the Romans in his war with Syria. He continued the patronage of literature, and added largely to the library of Alexandria. Like his predecessors he was the patron of scholars, and his court was the resort of the most distinguished men of his day. In his reign the Græco-Egyptian kingdom attained its highest prosperity at home, and its widest dominion abroad.

Ptolemy IV. (surnamed PHILOPATOR), son of Ptolemy III.; d. 205 B.C. He put to death his mother Berenice, his brother Magas, and his uncle Lysimachus, and abandoned the cares of state to his minister Sosibius, his adviser in these and other crimes. Roused from his lethargy by the loss of his Syrian possessions, wrested from him by Antiochus the Great, Ptolemy completely defeated Antiochus at Raphia, in 217. By this victory he recovered Cœle-Syria, but speedily made peace and returned to his pleasures. He continued in general the policy of his ancestors, patronized literature, and dedicated a temple to Homer as a divinity. During the Carthaginian war he supplied the Romans with corn.

Ptolemy V. (surnamed EPIPHANES), son and successor of Ptolemy IV.: d. 181 B.C. He was but five years old at his father's death and Philip of Macedon and Antiochus III. (the Great) of Syria combined to dispossess him, and divide his dominions. Instead of relying on the internal resources of the kingdom to repel this danger, the guardians of the young king took the fatal step of placing him under the protection of Rome. The charge was gladly accepted by that crafty state, and Philip and Antiochus were commanded to restore their conquests. Antiochus, to avoid embroiling himself with the Romans agreed, 199 B.C., to give Ptolemy his daughter Cleopatra in marriage, with the Syrian provinces as her dower. The marriage took place 198, and in the interval of peace Egypt began to recover prosperity under the administration of Aristomenes. After the death of Aristomenes the government of Egypt was chiefly conducted by Polycrates, who encouraged the king to give himself up to debauchery. Ptolemy was cut off by poison, while he was preparing to recover Cœle-Syria from Seleucus, the successor of Antiochus. Nearly all the foreign possessions of Egypt were permanently lost during the unfortunate minority of this reign.

Ptolemy VI. (surnamed PHILOMETOR), son of Ptolemy V., was also a child at the death of his father. His mother Cleopatra, who assumed the regency, maintained peace and preserved internal tranquillity by an able administration; but the ministers who succeeded after her death (173 B.C.) provoked a war with Antiochus Epiphanes, and were totally defeated near Pelusium. Antiochus advanced to Memphis and took Ptolemy prisoner (170 B.C.). Upon this the brother of Ptolemy caused himself to be proclaimed king at Alexandria, under the title of Ptolemy Euergetes II. Antiochus then re-established Philometor as king at Memphis, and returned to Syria. The brothers ruled jointly till 168. Dissensions now broke out between them, and Philometor, expelled from Alexandria, went to Rome 164 B.C. By the intervention of the Romans he was replaced, but agreed to erect Cyrene into a separate kingdom for Euergetes, who afterward persuaded the Romans to grant him Cyprus also. In the later part of his reign Philometor showed an energy of which he did not at first appear capable, and he is generally praised for the mildness and moderation of his character. During his reign a great migration of Jews, caused by factions in their own country, took place from Palestine into Egypt.

Ptolemy VII. (surnamed EUERGETES and also PHYSCON), son of Ptolemy V., was king of Cyrene at the death of his brother Ptolemy VI. d. 117. Cleopatra caused her infant son to be crowned; but Ptolemy invaded Egypt, and by the intervention of the Romans it was agreed that he should marry Cleopatra and be recognized as king. Immediately after the marriage he put his nephew to death. His reign was one of tyranny and bloodshed, and compelled at length to flee from the indignation of his subjects, he escaped to Cyprus 130 B.C. He was restored to authority 127, and died in peaceable possession of the throne of Egypt. He was not only a patron of literature, but the author of a considerable work on natural history.

Ptolemy VIII. (surnamed SOTER II., or LATHYRUS); d. 81 B.C. He was the son of Ptolemy VII. by the latter's niece Cleopatra. Already married to his sister Cleopatra at the time of his accession his mother compelled him to divorce her and marry his younger sister Silene, and for ten years she continued to sway the government, although she and her son were frequently opposed in policy. She accused him of conspiring against her life, and he was compelled to flee. For 18 years he held Cyprus as an independent kingdom. After the death of Cleopatra 90 B.C. he was recalled to Egypt, which he governed till his death. He was succeeded by his daughter Cleopatra.

Ptolemy IX., or **Alexander I.**, youngest son of Ptolemy VII.; d. Cyprus 81 B.C. On the expulsion of Ptolemy VIII. he shared with his mother Cleopatra the throne of Egypt, although he appears to have had little power. The violence of his mother at length caused him to flee; but persuaded to return, and suspecting her of designs against his life, he caused her to be assassinated. After reigning a year he was expelled by an insurrection of his people and soldiers, who recalled his brother.

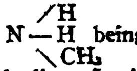
Ptolemy X., or **Ptolemy Alexander II.**, son of Ptolemy IX.; d. 80 B.C. He was nominated king of Egypt on the death of Ptolemy VIII.; but the Egyptians having already placed Cleopatra Berenice, the daughter of that king, on the throne, it was arranged that he should marry her and admit her to a joint sovereignty. Nineteen days after the marriage he caused her to be assassinated, upon which the Alexandrians rose in insurrection, dragged him to a gymnasium, and put him to death.

Ptolemy XI. (AULETES, surnamed NEOS DIONYSUS), an illegitimate son of Ptolemy VIII.; d. 51 B.C. He succeeded Ptolemy X., with whom the legitimate race of the Lagidae became extinct. In vice and debauchery he appears to have rivaled the worst of his predecessors. The oppressive taxes he imposed caused his expulsion by the Alexandrians in 58 B.C. In 55 B.C. A. Gabinius, proconsul of Syria, by the influence of Pompey and a bribe of 10,000 talents, was induced to restore him. The Egyptians, who had placed Berenice, the daughter of Ptolemy, on the throne, were defeated, and Ptolemy put Berenice to death. During the rest of his reign Egypt was occupied by the Romans.

Ptolemy XII. (AULETES), son of Ptolemy XI.; d. 48 or 47 B.C. He reigned jointly with his sister Cleopatra till 48 B.C., when Cleopatra was expelled, and raising an army in Syria invaded Egypt. It was at this time that Pompey landed in Egypt after his defeat, and was assassinated by the ministers of Ptolemy. On the arrival of Cæsar, Cleopatra by her charms acquired an ascendency over him, which made it manifest that he would decide her dispute with Ptolemy in her favor. Ptolemy put himself at the head of the insurgents, was defeated by Cæsar, and drowned in attempting to make his escape.

Ptolemy XIII. (AULETES), youngest son of Ptolemy XI.; d. 43 B.C. He was declared king by Cæsar in conjunction with Cleopatra in 47 B.C. He was married to his sister and was put to death by her. Consult: Mahaffy, 'The Empire of the Ptolemies' (1895); Strack, 'Die Dynastie der Ptolemäer' (1897); Meyer, 'Das Heerwesen der Ptolemäer und Römer in Aegypten' (1900); Budge, 'A History of Egypt' (1902).

Ptolemy (CLAUDIUS PTOLEMÆUS), Alexandrian astronomer: flourished about the middle of the 2d century after Christ, being born at Ptolemais in the Thebaid. The geocentric system of astronomy which he taught was accepted in Europe until after the time of Dante, whose poem takes this theory as its frame-work. In producing his principal work, '*Μεγάλη σύνταξις τῆς Ἀστρονομίας*' Ptolemy relied very much on the labors of Hipparchus; but his planetary theory is his own, as well as his theory of the moon's evection (q.v.). The Ptolemaic system of astronomy was only exploded by the arguments of Copernicus (q.v.). The mediæval writers speak of the astronomical treatise of Ptolemy under its Arabian name of the Almagest. It consists of 13 books, the principal of which, the first, reveals the trigonometrical theory of the Greeks; contains a method for calculating chords, and demonstrates the basal doctrine of trigonometry, that the rectangle of the diagonals of an inscribed quadrilateral equals the sum of the rectangles of the opposite sides. There is also to be found there sufficient spherical geometry and trigonometry to enable a calculation to be made of the sun's declination to each degree of longitude. These principles are applied in detail through the remaining 12 books. The predecessor of Ptolemy in the field of geography was Marinus Tyrius, whose works he utilized and corrected. His geographical treatise is entitled *Γεωγραφικὴ Ὑφήγησις*, and contains little more than a list of places with their longitude and latitude. He also corrects the geographical methods of Eratosthenes, Hipparchus and Marinus, and he actually executed 26 maps in illustration of his theories. There are other spurious works of Ptolemy, and many of his writings have been lost. Consult: Voll, 'Studien über Claudius Ptolemäus' (1894).

Ptomaines, a series of organic nitrogenous bodies, closely resembling the vegetable alkaloids in many of their chemical properties. They are present in many animal products, and are formed either by the chemical breaking down of complex nitrogenous molecules or by bacterial agencies capable of inducing similar decompositions. Most of the ptomaines are ammonia compounds. By the older chemists all of this group of so-called animal alkaloids were termed ptomaines, but later studies have given a series of groups of these bodies. Thus ptomaines, leucomaines, and toxins are at present recognized; the former being the results of abnormal catabolic changes, due to chemical or bacterial agencies; the leucomaines being usually normal catabolic compounds of this group. The toxins are ptomaines, products usually of bacterial decomposition or ferment activity of some type or other, and which are poisonous. Modern conceptions regarding these bodies are modifying so rapidly that hard and fast definitions are apt to be more misleading than informing. Many of the ptomaines are inert; others, the toxins, are poisonous, some highly so. Ptomaine-poisoning resulting from eating altered sausage meat, mussels, tinned meats, etc., is due to some form of toxin. Chemically the ptomaines contain carbon, hydrogen and nitrogen. They belong mostly to the amines or substituted ammonia compounds, monomethyl amine,  $N\begin{matrix}/H\\—H\\\backslash CH_3\end{matrix}$ being one of the simplest of these bodies. It is present in many decomposing foods, and even as mercurialine in a living plant. Dimethylamine, $(CH_3)_2NH$ and tri-methylamine, $(CH_3)_3N$, are similar ptomaines of this simpler group. Amines of higher alcohols are also common forms, ethylamine, butylamine and others being examples. Putrescine and cadaverine are more complex ptomaines which have been isolated from putrescent meat. They are both diamines. Neuridin, $C_5H_{14}N_2$, was one of the first of this class isolated by Brieger, the practical founder of the study. Choline, neurine, betaine, and muscarine are four oxygenated ptomaines of closely related chemical structure that are peculiarly convertible one into another by simple chemical processes. Choline is non-poisonous, but neurine and muscarine are highly toxic. They are found in decomposing meat. Muscarine, from the poisonous fly-mushroom, is thought to be identical or very closely similar to the choline, neurine, muscarine compound. Mytilotoxin is the specific poison of the mussel. Typhotoxin and tetanotoxin are ptomaines supposed to be the active poisons produced by the typhoid fever and lockjaw bacteria. Tyrotoxicon is a toxic ptomaine found in cheese and in ice cream. At least 200 ptomaines have been described. Consult: Vaughan and Novy, 'Cellular Toxins' (1902), for a full consideration of all of the many new lines of thought on this subject.

Ptosis, tō'sĭs, a falling or drooping of the upper eyelid owing to paralysis of the muscle that lifts it. It is sometimes congenital, and it may be produced by various disorders of the brain.

Pty'alin. See SALIVA.

Pty'alism. See SALIVATION.

Pu-lu, poo'loo. See *Filicales* (6) under FERNS AND FERN ALLIES; FIBRE.

Pu'berty, the period in both male and female marked by functional development of the generative system. This period, when capacity for reproduction begins, is indicated in both sexes by certain characteristic signs. In the male puberty is generally reached, in temperate climates, between the ages of 15 and 18, and although it is commonly believed to be reached somewhat earlier in warm regions, climatic conditions appear to affect the male less than the female. Before the attainment of this period the physical powers have been appropriated to the nutrition of the body. This is in accordance with a well known law of physiology, whereby the processes of nutrition and reproduction are mutually antithetic; the reproductive energies are opposed to the nutritive, and act as an important drain upon the physical and nutritive powers. Therefore the generative instincts are limited or restrained until nutrition and growth have been duly advanced.

In the male the occurrence of puberty is marked by a varied and general change in the physical constitution. The body attains, within a comparatively short period, a large relative increase in size. The form acquires greater fulness and stamina. The larynx particularly enlarges; the voice deepens; there is a growth of hair upon the face, the pubes, etc.; and the entire sexual system receives an unwonted stimulus, the testes secreting the seminal fluid characteristic of full sexual vigor. The male thus reaches sexual maturity. In ordinary cases his virile powers decrease after the age of 50 or 60, when the energies seem to be withdrawn from the reproductive function in the interest of nutrition.

In the female the state of puberty usually begins, in temperate climates, between the 14th and 16th years. At this period the female form acquires a characteristic fulness and roundness. The breasts enlarge, depositions of fat taking place in the mammæ and on the pubes, and over the body generally. The internal organs of generation also enlarge, and their functional perfection in woman is marked by the most unequivocal of the signs of puberty, the appearance of menstruation (q.v.). The production of ova, ready for fertilization, is the most essential and significant sign of the full attainment at once of puberty and of the true female generative functions. (See OVARY.) Puberty in both man and woman may be retarded or advanced by individual and inherited peculiarities of constitution and by modifying circumstances and habits of life.

Public Debt, United States. See DEBT, NATIONAL; DEBT, PUBLIC; FINANCE.

Public Domain, The. The United States is the only great nation in the world which has passed title to the bulk of its territory direct to the intending occupant. In the earliest years of the nation, when government was organized over a comparatively limited area along the coast of the Atlantic Ocean, the federation of

States had no control over the land within the boundaries of each separate commonwealth. Eighteen States, Maine, New Hampshire, Vermont, Rhode Island, Massachusetts, Connecticut, New York, New Jersey, Delaware, Pennsylvania, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Tennessee, and Kentucky, each retained jurisdiction over their own land, and disposed of the same as the local governments saw fit.

Later on, when Texas was admitted to the Union, that State also retained jurisdiction over its public domain and is administering the same to-day under State laws and entirely independently of national control. Without exception, all other territory of the United States, including Alaska, has been disposed of by Congressional action. Since the United States went into the land business the government has acquired for sale and disposal nearly 2,000,000,000 acres of land on this continent. This vast public domain reached from the eastern boundary of Ohio to Puget Sound and from Florida to California, with Texas as the only break in its continuity.

For a century the United States has been known to the people of all the world as the country of free homes, with the result that the land-hungry millions, flocking hither, have built up a great nation with such rapidity that the history of the world affords no parallel. Leaving Alaska and the new possessions out of consideration, owing to peculiar and unsettled conditions existing therein, Congress in its legislative capacity, and the Interior Department in its executive capacity, have since the foundation of this government been given control of over 1,500,000,000 acres of land. There have been reserved from sale and settlement, for various purposes and for reasons of public policy, about 170,000,000 acres. Under various authorizations from Congress, title to about 800,000,000 acres has passed from government to other ownership. The government still holds for sale or gift, as the law may direct, something less than 500,000,000 acres of land, practically all of it lying between the Mississippi River and the Pacific Ocean on the east and west respectively, British America to the north and Mexico to the south.

The people of the United States acquired title by cession, occupation, and purchase to the area now occupied on this continent. At least three quarters of this territory was acquired by purchase. Including the cost of survey and administration, the nation has paid over $400,000,000 in cash for this realty. The sales of land have returned over $350,000,000, thus leaving $50,000,000 approximately as the net cost of the remaining 500,000,000 acres still upon the market. These figures are necessarily valueless, however, for the purpose of arriving at a balance, for in addition to the actual cash paid for the land, the cost of war, political and criminal jurisdiction, and a certain proportion of the cost of running all departments of the government can rightly be charged to this land account. Speaking in the narrower sense, the people have paid about 20 cents per acre for their public domain. This includes merely the original sum invested, and the cost of survey and administration. The average price received for land sold has been about 40 cents per acre. Few administrations have considered this department of the government from that point of view, however, the real purpose of the disposal being that of populating and developing the country. The cash account has been held as of little concern.

Over 100,000,000 acres of public land have been given away in the form of bounties and for military service, and over 10,000,000 acres have been given to the various States for express purposes, generally educational. Nearly 100,000,000 acres passed to individuals under the so-called swamp reclamation law, long since repealed, through which by means of perjury and misrepresentation valuable agricultural land was stolen in enormous tracts. Over 100,000,000 acres have been donated for educational purposes, most of this land passing under the jurisdiction of State governments for that purpose. Millions of acres have been alienated under the mineral land law, grants for wagon roads, under laws providing for the location of salt, stone, and timber at minimum acreage prices. During the past 50 years over 100,000,000 acres have been disposed of as railway grants, much of this land being of the very best character. With all this liberality, however, Congress must be given credit for having refused to consider thousands of wild-cat schemes whereby millions of acres of the public domain were to be diverted to individual ownership. No session of Congress has passed without the introduction of numberless bills, each proposing a land grant to some allegedly meritorious enterprise. These propositions have taken a remarkable range. Grants of land have been asked for to aid in Arctic exploration, to start dairies, private schools, to pay the expenses of trips abroad, and in fact, it would be difficult to name any industry or branch of human invention which Congress has not been asked to favor with a land grant.

Of the vast amount of money paid by the government for its public estate, nearly half, or about $200,000,000, has been paid to the Indians for quit claim deeds to territory under their control. The record of sales also shows that the government has paid in cash more for the Indian lands than white settlers have been charged for similar lands, to say nothing of the rations, supplies, and interest on deposits, and other valuable privileges granted the Indians in return for their holdings, to which their title at the best was more or less indefinite. The United States has also paid nearly $100,000,000 to individual States and foreign countries for land. To survey the entire public domain and pay the expenses of the land office from the foundation of the government to the present day has cost nearly $200,000,000.

When the United States government first went into the land business, the only idea prevailing was to sell the public domain in any quantity to any one who might apply, at such price as could be realized. This system practically prevailed until 1841. In that year was first recognized the desirability of limiting individual holdings, and an attempt was made to discourage non-resident ownership. By this time the government had disposed, under previous arrangements, of over 150,000,000 acres. In 1841 the preemption law was enacted. This was the first legal recognition of the fact that 160 acres, or a half-mile square, is the ideal size for a farm, being sufficient agricultural land to fully occupy the energy and attention of a single family and yield, under conditions prevailing in the United States, an adequate return. Under the provisions of this law any citizen could take 160 acres of government land and secure title thereto by paying $1.25 per acre after living six months upon the property. In 1862 Congress enacted the homestead law. This measure reflected the views of those who believed that the public land should be given at minimum cost to such people as would show their good faith as home-builders by a continuous residence of five years, and an honest attempt at cultivation. This proved a slow process, however, for those desiring to increase their land holdings, and the law was soon amended so that after six months residence a settler could obtain title by paying $1.25 per acre, thus commuting his option of obtaining it free if he lived upon it for five years. Later on the law was again amended into the shape in which it now is, extending the time of residence from six months to 14 months before commutation was allowed. In 1873 the timber culture law was passed, which gave the settler the opportunity of acquiring another 160 acres by planting a certain number of trees. The law was apparently correct in principle, but in practice the conditions were found to be almost impossible of fulfilment, especially upon the semi-arid plains of the West, and the law was finally repealed as offering inducements to fraud. In 1875 another law was enacted which offered 640 acres of arid land to any settler who would fulfil certain conditions of reclamation by carrying an artificial supply of water thereto and paying the government $1.25 per acre in addition. This law still stands, but has been so amended as to reduce the amount of land which can be taken by each claimant to 320 acres, and the conditions of reclamation have been made more severe. This law originated in California, and when it was first enacted in 1875 it applied only to that State. Its application to all of the public land States was made general in 1877. In 1891 Congress became alarmed at the inroads which were being made upon the public domain by those who were manifestly not legitimate settlers. The laws as they then stood enabled a single claimant to secure 1,120 acres of land at comparatively little expense to himself and without complying seriously with the purpose of the whole plan of public land disposal, that of residence and cultivation. On 3 March 1891 the agitation over this matter resulted in the repeal of the preemption and timber culture laws. Under the timber culture law nearly 37,000,000 acres had been disposed of, and even under the lax administration of the conditions required, less than 9,000,000 acres had been earned by planting trees as the law specified.

The laws now in force governing the disposal of the agricultural portion of the public domain are, therefore, the homestead law and the desert land law. The homestead law gives the settler two options: he can settle upon, enter, and acquire title to 160 acres of land practically free of cost, by establishing and maintaining residence thereon for a period of five years. He may, on the other hand, at the end of 14 months of such continuous residence, secure a patent from the government by paying $1.25 per acre for his land, if it lies without the limit of railroad grants, or $2.50 per acre if within such limits.

In either case actual residence, improvement, and cultivation are at least theoretically required. He must, according to the law, make application for this land in "honesty and good faith," not as an agent for others, but with the intention of making it a home, and all agreements to sell prior to the issuing of the patent are forbidden. Since the passage of the homestead act in 1862 there have been about 1,500,000 original homestead filings, involving an area of about 200,000,000 acres or more. About 50 per cent of those who have made original homestead filings have carried the process through to completion and received title to the land.

Since the Desert Land Act was passed in 1875 about 12,000,000 acres have been preempted under its provisions, though less than 3,000,000 acres have been finally proved up upon. As the law now stands, any citizen of the United States or person who has declared his intention of becoming such can take up 320 acres of arid land by making a deposit of 25 cents per acre at the time of filing and paying $1 per acre more when title is asked of the government. The law requires that before securing title the settler shall prove the ownership of sufficient water to irrigate the entire tract, shall prove that he has expended at least $1 per acre each year in improving the land, and that he has actually irrigated within three years from the time of filing, every legal subdivision or 40-acre tract of his claim. Experience has proved that an average expenditure of at least $10 per acre is necessary to fully comply with the letter of this law.

There have been a number of special laws enacted with the intention of encouraging the settlement of the arid and semi-arid public domain through indirect agencies. The most notable of these is the so-called Carey Act, which proposes to grant to each State 1,000,000 acres of arid land, title to be passed from the general government to the State when such land is reclaimed by irrigation. A few of the States have taken advantage of this law, made selections from the public domain within their borders and offered inducements to private capital to undertake the enterprise. The workings of the law have not been entirely successful. Wyoming, the home of Senator Carey, the author of the act, being the only public land State to take advantage of the opportunity to any extent. Idaho and Washington have seriously attempted the reclamation of large areas in this manner, but as yet without notable success.

Among the most important features of the land laws are those provisions whereby mineral claims can be secured by individuals. The regulations governing the securing of mineral rights or rights to mine upon the public domain, vary in different mining districts; but under the federal law any citizen can stake out a limited amount of ground, and after proving that he has expended a certain amount of money for development work can receive title to his claim. The acreage taken from the public domain under the mineral land laws is inconsiderable in itself, but from this acreage has come a great part of the wealth of the nation. There are also laws providing for the taking up and purchase from the government of coal lands, salt claims, stone and timber. With a few notable exceptions these laws have operated to the development and prosperity of the country. What is known as the timber and stone act has been notoriously abused in its application to timber land. This law allows any citizen to secure 160 acres of saw-mill timber by filing a claim and paying the government $2.50 per acre for the land. The General Land Office at Washington estimates that nearly 5,000,000 acres of valuable timber has been so disposed of by the government at a price sometimes returned to the purchaser by the sale of a single tree from an acre of his quarter section, or 160 acres. In other words, the government has probably sold for less than $13,000,000 timber conservatively estimated to be worth at least $100,000,000. As the population of the United States increases, and the conservation of resources receives more and more attention, it is realized that the arable land and forest timber of the nation has been distributed with lavish, not to say careless, generosity, the results of which are already felt in the exhaustion of the free-home area and a narrow limit to the once apparently inexhaustible timber supply of the country.

During recent years conditions have changed with marvelous rapidity. For a century the building of homes has only been limited by the number of home-seekers. The land lay fallow awaiting the plow. As the plow turned its furrow the guiding spirit could foretell the almost immediate harvest. This is no longer true, for there is now hardly a spot left in the great public domain of the United States where the hardiest pioneer, without resources other than willing hands and indomitable spirit, can successfully establish himself. The easily arable habitable public land has all been reserved or segregated to private owership. What is left is wonderfully valuable and susceptible of the highest production, but under different conditions of settlement from those which have heretofore prevailed. It is estimated that the remaining public domain, if scientifically developed, will support in comfort at least three times the present population of the entire United States. A partial recognition of this condition was secured from Congress in 1902 by the enactment of a National Irrigation Law. The fight preceding the enactment of this law recalled to older members of Congress the desperate struggle necessary to secure the passage of the Homestead Law in 1862. The National Irrigation Law is, in reality, a modified Homestead Act, made particularly applicable to the arid public domain. It provides that the government shall create an artificial water supply by the building of storage reservoirs and the diversion of rivers, and then dispose of the land reclaimed thereby to actual settlers who will not only live upon it, but who will, through a series of annual payments, return to the government the cost of irrigation. In this law the principle of residence and cultivation is more fully recognized than in any land law upon the statute books. Speculation is practically impossible, and the enterprise possesses no attractions for others than home-seekers. This law is a recognition of the need for a general revision of the land laws, in view of the very great changes which have taken place in the conditions of settlement since the earlier days of American pioneering. Under the terms of the National Irrigation Law the money derived from the sale of public lands is to be devoted to the reclamation of the arid region.

THE PUBLIC DOMAIN, 1910.

STATE	Area uappropriated and unreserved			Public lands	
	Surveyed	Unsurveyed	Total	Surveyed	Unsurveyed
	Acres	Acres	Acres	Acres	Acres
Alabama	108,210	....	108,210	32,818,560	....
Alaska	....	368,014,735	368,014,735	15,265	378,150,495
Arizona	12,361,814	29,129,555	41,491,369	21,131,584	51,726,016
Arkansas	512,705	....	512,705	33,616,000	....
California	18,803,012	6,061,872	24,864,884	78,295,333	21,603,547
Colorado	19,432,009	2,294,183	21,726,192	62,784,176	3,556,944
Florida	391,361	61,648	453,009	30,912,571	4,198,469
Illinois	....	....	....	35,841,280	....
Indiana	....	....	....	22,966,400	....
Iowa	....	....	....	35,575,040	....
Idaho	7,237,279	17,506,525	24,743,804	26,195,876	27,422,684
Kansas	137,180	....	137,180	52,335,360	....
Louisiana	88,911	....	88,911	27,176,996	1,884,764
Michigan	107,890	....	107,890	36,787,200	....
Minnesota	1,516,302	47,000	1,563,302	49,457,190	2,291,930
Mississippi	47,058	....	47,058	26,671,680	....
Missouri	2,510	....	2,510	43,985,280	....
Montana	17,266,811	18,749,132	36,015,943	55,597,827	37,698,813
Nebraska	1,879,486	....	1,879,486	49,157,120	....
Nevada	29,790,500	26,684,188	56,474,688	39,594,944	30,690,496
New Mexico	23,576,992	12,877,700	36,454,692	53,486,719	24,915,201
North Dakota	1,410,225	....	1,410,225	42,553,931	2,363,189
Ohio	....	....	....	26,073,600	....
Oklahoma	5,007	....	5,007	44,424,960	....
Oregon	13,463,734	4,116,839	17,580,573	49,052,281	12,136,199
South Dakota	4,375,864	186,940	4,562,804	49,109,626	85,894
Utah	11,766,486	24,189,068	35,955,554	25,900,630	26,697,130
Wisconsin	1,258,587	1,937,472	3,196,059	35,363,840	....
Washington	14,460	....	14,460	32,022,203	10,752,837
Wyoming	31,914,779	2,660,380	34,575,159	56,829,418	5,630,742
Totals	197,469,172	514,517,237	711,986,409	1,178,732,890	641,805,350

In 1904 the fund represented an accumulation of about $16,000,000 with a promise for several years to come of annual additions amounting to at least $5,000,000 more. The theory of the law implies a revolving fund, as the money is to be returned to the government by the beneficiaries. If this plan works out successfully, the government will in course of time be able to utilize fully, for the benefit of the arid region, all possible sources of water supply.

In 1904 the General Land Office issued an estimate of the status of the public domain on the North American Continent. This is comprised within the United States proper and the Territory of Alaska. The result may be seen from the table on the preceding page.

In the foregoing table, the territory in the Philippines, Porto Rico, and other new possessions is not included. In securing this new territory the United States fell heir to a large area formerly under Spanish sovereignty, but with more or less indefinite title. When the governments of these new countries were finally organized by Congress, it was decided to give the title of all public land into the hands of the local authorities, hence they did not become part of the public domain of the United States within the strict meaning of the term. The Philippine government and the government of Porto Rico have since enacted laws indicating the manner in which land can be disposed of. These regulations are necessarily more or less temporary and experimental. It will be several years before surveys can be completed and the boundaries of tracts already in private ownership determined. Effort has been made, however to embody the homestead idea and thus encourage settlement upon small holdings. The problem of dealing with tropical areas has yet to be worked out through actual experience. There has been as yet no great demand for this land except by exploitation companies interested in the mining or lumber industry. Profiting by past mistakes, Congress has been very slow to grant many privileges of this kind, but in course of time some plan will be adopted whereby the valuable natural resources of the new possessions can be utilized without permanently destroying their recuperative power.

In the table above given it will be noted that of the more than 863,000,000 acres remaining about 368,000,000 acres are credited to Alaska. This territory is as yet practically unsurveyed, and its possibilities undetermined. Mineral land laws and regulations are in force similar to those prevailing in the older States, but the agricultural possibilities are so indefinite that little necessity has yet arisen for providing for homeseekers. A great future has been predicted for Alaska in the direction of agriculture, but with vast areas not only in the United States, but in adjoining Canadian territory, still open for settlement, it is not probable that much will be done in the direction of farming in Alaskan valleys, other than to attempt to supply the local demand for produce created by the mining settlements.

That portion of the public domain marked reserved amounts to about 170,000,000 acres. In this area are included military, Indian, and forest reservations. The military reservations are quite numerous, but small in acreage and are gradually being done away with. The Indian reservations are large and included among them is the whole of Indian Territory. By treaty, purchase, and individual allotment to the Indians these reservations are rapidly decreasing in size, and some time in the future they will practically disappear. The forest reservations amount to over 60,000,000 acres and are the most important feature of the more modern and scientific administration of the public domain characterizing government control. Under authority given by Congress the President of the United States has the power to withdraw from settlement any portion of the public domain which may be determined to be more valuable for forest conservation and the protection of watersheds than for promiscuous disposal under existing land laws. This authority has been freely exercised within the past five years and great areas of noble timber have thus been preserved from speculators, and the water supply of nearly all the great rivers rising in the western mountains has been assured by perpetuating the wooded covering of the hills and valleys at their sources. That these reservations will be extended until practically all the great virgin forests are protected is a foregone conclusion, for in 1904 over 50,000,000 acres of forest and woodland were under consideration for possible addition to the reserved territory. The sentiment of the country has been very much divided as to the wisdom of this wholesale reservation of forest. The prosperity of the West, in many sections, depends upon free access to timber for mining, construction, and domestic purposes. From these sections has naturally come no little opposition to the creation of forest reserves, but with the adoption in the near future of a scientific system of forestry which will allow of lumbering without total destruction, and the general encouragement of reforestation this opposition will be overcome.

The table showing the area of unappropriated public domain still existing in the States and Territories shows that a greater part of it lies in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah and Wyoming. Notwithstanding the many years the Southern States have been settled there still remains within the boundaries of Alabama, Arkansas, Florida, Louisiana, Mississippi, and Missouri considerable unappropriated land. Most of this land is worthless, however, and is found on rocky ledges and mountains where the timber is not of sufficient value to induce the exercise of citizens' rights to obtain it from the Federal government. In one or two of the Southern States, however, notably in Mississippi, there has been a recent and rapid absorption of the few remaining acres, this being due to the increasing value of pine timber and the discovery that there was enough of such timber on some of these tracts to warrant their being preempted under the homestead law.

Nevada is the most notable example of a State where the preemption of a small percentage of its total area has resulted in a check to the absorption of the balance into private ownership. But a little over 4 per cent of the surface of Nevada is owned by private individuals. Owing to the arid character of the land and the control of the water supply within the boundaries of this 4 per cent, the other 96 per cent is valueless, except possibly for limited grazing purposes. It is in such States as this that the national irrigation work is expected to produce the greatest results in the direction of opening new territory available for home-seekers. One of the great problems connected with the administration of the public domain has been the control of the grazing privilege. The great industry of the West, that of raising live-stock upon government-owned land, rests entirely for its support upon this privilege. Congress has shown a marked disinclination to perpetuate government control of the public lands by initiating any form of lease which would exclude the possible home-builder. There are many millions of acres, however, which so far as can be seen now will never be used except for grazing purposes, and in time some form of government control which will result in the production of revenue and a conservation of this great property must be adopted.

At various times Congress has passed laws giving land rights in payment for services performed or property confiscated. These laws resulted in the issuing of what is known as land scrip, and out of the use of this scrip grew many abuses which caused the practice to fall into disfavor. There are, perhaps, less than 2,000,000 acres of scrip not yet utilized, and it commands a ready sale upon the market at good prices. The amount used each year is inconsiderable, however, and it is gradually disappearing. When a forest reservation is created, owners of private holdings within its boundaries are compensated by being given the privilege to locate an equal acreage upon other public domain. There have been serious abuses of this privilege also, for very often land almost valueless in character has been traded to the government for new location privileges which were used upon valuable forest areas. The readily salable lands have disappeared, blindly distributed with lavish hand at minimum prices and in almost unlimited areas to whomsoever might apply. From the very richness and value of the land much gain to the country as a whole has come. State after State has been added to the Union by virtue of the settlement of public lands. Cities and towns have been built and a nation has grown to manhood. Apparently unlimited in area and unparalleled in richness, the land has passed from the government without much public concern, and, with the evils accomplished, lost sight of in the great growth of the country. Nearly every secretary of the interior for 25 years past, however, has been so impressed with the dangers of an approaching crisis that an alarm has been sounded from each administration. Thoughtful men of the present day are now concerned with this economic problem peculiar to the United States and the public land administration during the 20th century promises to be of a more conservative character than that which prevailed during the 19th.

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Public Domain. The lands constituting the public domain of the United States were acquired through treaties and cessions from foreign governments, and the original States of the Union and by annexation.

By the definitive treaty of 1783 England relinquished all lands east of the Mississippi River which lay north of the 31° of north latitude, but all lands east of the Alleghanys were claimed by the original States, while all lands between the Alleghany Mountains and the Mississippi River, except the extreme northern and southern portions, were claimed by Massachusetts, Connecticut, New York, Virginia, Georgia, and the Carolinas, under the terms of their original crown grants, which described the lands granted as extending westward to the «South Sea» or Pacific Ocean. There was nothing in the grants to the other six colonies which could form the basis of such a claim, and upon the formation of the Union they jealously protested against the continued ownership of the lands west of the mountains by the States named, and these lands were later relinquished to the national government as follows:

In 1781 New York ceded without reservation 202,187 acres, now in the county of Erie, Pennsylvania. In 1784 Virginia ceded 169,559,680 acres north of the Ohio and east of the Mississippi rivers and known in subsequent legislation as the «Northwest Territory,» reserving therefrom 150,000 acres for the benefit of George Rogers Clark and the officers and soldiers who aided him in his successful expedition into that country against the British, and also so much of 3,800,000 acres in Ohio as should be needed to satisfy certain donations to her Revolutionary soldiers. This cession also contained a stipulation that the possession of French, Canadian, and other settlers of Kaskaskias, Saint Vincents, and other neighboring villages, who then professed to be citizens of Virginia, should be recognized and confirmed. In 1785 Massachusetts ceded without reservation 34,560,000 acres, which now forms a part of southern Michigan and Wisconsin and northern Illinois. In 1786 Connecticut ceded 26,600,000 acres, which now forms the northern parts of Ohio, Indiana, and Illinois, reserving, however, 3,800,000 acres — a strip in northern Ohio, 120 miles long, which was afterward known as the «Western Reserve,» and of which Connecticut donated 500,000 acres subsequently known as «Fire Lands,» to certain of her citizens who had suffered loss by fire and raids during the Revolutionary War. The remainder of the lands reserved by Connecticut were sold to a company for $1,200,000. In 1787 South Carolina ceded without reservation 3,136,000 acres — a strip 15 miles wide, which now forms the northern parts of Georgia, Alabama, and Mississippi, while in 1790 North Carolina ceded 29,184,000 acres which now forms the State of Tennessee, reserving the right to satisfy therefrom certain donations made to her soldiers and certain claims theretofore initiated under her land laws which absorbed the bulk of the lands embraced in her cession. In 1802 Georgia ceded 56,689,920 acres, now forming parts of Alabama and Mississippi, in consideration of the payment to her of $1,200,000 and the satisfaction of certain outstanding obligations known as the «Yazoo Claims,» the settlement of which finally cost the United States $5,000,000.

The claims of Massachusetts and Connecticut, based upon their crown grants, conflict with the claim of Virginia which she asserted under her grant, and also by virtue of the successful expeditions of her State troops under George Rogers Clark into that country.

In 1803 France ceded 757,961,920 acres, now known as the «Louisiana Purchase» (q.v.), the government paying therefor $27,267,621, including interest, etc. These lands now constitute a part of Mississippi, Alabama, Texas, Colorado, Wyoming, Montana, and the States lying between them and the Mississippi River. In 1819 Spain ceded 37,931,520 acres, now constituting the State of Florida, at a total cost of $6,289,768. In 1848 Mexico ceded 334,443,520 acres, now constituting the States of California, Nevada, Utah, and parts of New Mexico, Arizona, Colorado, and Wyoming, at a cost of $19,250,000. In 1850 Texas ceded 61,892,480 acres, now constituting a part of New Mexico, Oklahoma, and Colorado, for $16,000,000. In 1853 Mexico ceded 29,142,400 acres, known as the «Gadsden Purchase,» now part of New Mexico and Arizona, for $10,000,000. In 1867 Russia ceded all of Alaska, embracing approximately 599,446,000 acres, for $7,200,000. In 1897 the Hawaiian Islands, containing 4,313,600 acres, were voluntarily annexed. In 1898 Spain ceded Porto Rico, containing 2,304,000 acres; Guam, 112,000; the Philippine Islands, containing 91,520,000 acres, for $20,000,000. In 1899 Tutuila and other small Samoan Islands, containing in all 46,720 acres, were annexed. In 1901 Spain ceded Sibutu and other small islands, containing in all 43,520 acres, for $100,000. The «Oregon Country,» containing 183,480,960 acres and embracing Oregon, Washington, Idaho, and part of Montana, was claimed by the United States through discovery and exploration and that claim was afterward recognized by England and Spain.

That part of the lands ceded by South Carolina which lay north of Georgia was, by act of Congress, added to that State; the lands ceded by North Carolina, which remained unabsorbed in the satisfaction of her outstanding claims, were donated to Tennessee; Virginia consented to the creation of Kentucky from her unceded western lands. The lands ceded by New York were sold to Pennsylvania, and New York relinquished her claims to lands in Vermont, while Massachusetts consented to the erection of the State of Maine from lands claimed by her under her original charter. All of these States disposed of the lands within their borders under their own law and for their own benefit. The act under which Texas and Hawaii were annexed authorized them to hold and dispose of their lands, and the public lands in Porto Rico and the Philippines are to be disposed of by their local authorities under laws and regulations specifically applicable to them. All of the other lands mentioned above are disposed of for the benefit of the national government under a general system of laws applicable mainly to all alike with the exception that a modified system is applied to lands in Alaska.

Three forms of government existed in the colonies out of which the Union was formed — that of New Hampshire, New York, Virginia, Georgia, and the Carolinas being provincial; that of Pennsylvania, Delaware, and Maryland being proprietary, while that of the other was created by charters. Notwithstanding these differences lands in all of the colonies were held of the Crown, in fee and common socage, and not *in capite*, or by knight service. No trace of feudal tenures, such as existed in England, was found among them, and their different systems of disposing of their public lands furnished the germ and basis of the principal methods afterward adopted by the federal government.

In some instances large grants were made to favorites of the Crown, but the bulk of colonial lands were sold under local laws and regulations at 50 cents and upward per acre, with quit rent stipulations, and to actual settlers and occupants who were given preferred rights and protected in them. In some instances every immigrant, and the person who sent or brought him, each received a donation of lands, with an additional donation when the first had been occupied and cultivated.

Methods of Disposing of Public Lands.— Two antagonistic theories have at different periods controlled in the disposal of public lands. The first was the theory that the lands were an asset of the government to be handled and disposed of by it for revenue purposes only, and the second was the theory that they should be held by the government in trust for distribution to and actual use by the people in the manner most conducive to their occupation, cultivation, and home building. The revenue theory first controlled in this country. The Continental Congress, having no power to levy taxes for the payment of its war debt, induced the States owning lands west of the Alleghanys to relinquish them to the national government on the theory that they were «important resources» from which that debt could be discharged. Settlements upon public lands were discouraged and in fact forbidden by Congress in 1785 and 1804, and later the President was empowered to use soldiers to enforce the removal of settlers. In 1785 auction sales at $1.25 per acre in unlimited amounts were authorized, but prior to the adoption of the Constitution but three sales had been made — one to the Ohio Company for 822,900 acres, one to John Cleves Symmes, under which 248,540 acres were patented, and another to the State of Pennsylvania for 202,187 acres, now in Erie County. In 1790 Alexander Hamilton, then secretary of the treasury, submitted a detailed plan for the disposal of the public lands, which embraced the basic principles of both the colonial and the present systems. In 1795 the substance of the present system of surveys into rectangular townships, six miles square, containing sections of 640 acres each, was provided for, and auction sales of unlimited amounts, at not less than $2.00 per acre, were authorized. This system was modified in 1800, and speculators, stimulated by the prospects of early sales to immigrants who continued to come to the new country in constantly increasing numbers, took advantage of the credit system authorized by this law and purchased so largely in excess of their means that 5,756,622 acres of the 19,399,158 acres sold prior to 30 June 1820 were forfeited for nonpayment of the purchase money, and the government, instead of receiving $47,689,563, received $27,900,279 from that source.

The inability of purchasers to meet the payments upon their lands caused distress in the newly settled country and the clamor for relief became so great that the law was repealed in 1820 when the minimum price of lands was reduced to $1.25 per acre, and all lands which had failed to sell when offered at public auction could afterward be bought in unlimited quantities at that price.

The theory that the public lands should be regarded as a source of revenue early met with opposition in this country as well as in England. In 1785 Edmund Burke brought a bill before the British House of Commons under which he strongly advocated the opposite theory as the sounder principle of political economy. He contended that any measure which would induce a more extensive settlement and cultivation of the soil would more greatly benefit the government, and this doctrine was adopted and strongly urged by the minority in this country until it resulted in the pre-emption system which preferred the settler above the speculator. This system found its origin in 1801, when Congress protected the settlers on lands which had been excluded from the original purchase made by Symmes, and continued to grow under the active support of President Jackson, Senator Benton, and others, until it developed through various amendments into the pre-emption law of 1841, which continued in force with slight modifications until it had outlived its usefulness and was repealed in 1891. Approximately, 200,000,000 acres of lands were disposed of under this act.

Under this system a citizen with certain prescribed qualifications could, after residing upon cultivating, and improving the land, to a limited extent, purchase it at $1.25 per acre.

The theory that the largest possible inducement should be offered to the home builder found its fullest expression in the present homestead law, under which citizens having other requisite qualifications may obtain title to 160 acres of public land, without paying for the same, by simply residing upon and cultivating it for five years. The theory of this law, long advocated, found a place in a political platform in 1852, and remained an issue before the people until it became a law in 1862, having been introduced by Representative Galusha A. Grow of Pennsylvania. Under this law 118,920,159 acres had been patented prior to 30 June 1910.

In 1878 a law was enacted to encourage the growth of timber in the treeless regions, under which title could be obtained to 160 acres by planting and cultivating 10 acres of timber. This law was repealed in 1891.

Any citizen or person who has declared his intention to become a citizen of the United States may now purchase, at $1.25 per acre, not exceeding 320 acres of arid lands reclaimed by them through artificial irrigation, or he may purchase at $2.50 per acre 160 acres of lands more valuable for timber than for agriculture.

Lands containing valuable mineral deposits may be purchased at $2.50 per acre for placer mines, $5.00 per acre for lode mines, or $10.00 and $20.00 for coal lands, owing to their proximity to a railroad.

A large amount of public lands have been set aside as reservations for occupation by the Indians, for military purposes, for the protection of forests, etc., which are not subject to any kind of appropriation under the public land laws — 192,931,197 acres having been reserved for the protection of forests alone prior to 30 June 1910.

Scrip of various kinds and warrants issued for military services in the wars of 1812 and the Mexican War have been issued, under which a large amount of lands have been disposed of, about 60,000,000 acres having been patented for military services alone.

The policy of encouraging education in the newer States by liberal grants of land was early adopted and resulted in donations, at first of one section of 640 acres and later of two sections in each township, and in some instances special additional grants were made, and 5 per cent of the receipts from the cash received for lands were donated to the States.

Internal improvements, and particularly the construction of wagon and rail roads, have also been encouraged by large grants of public lands, under which more than 112,000,000 acres have been patented.

To induce their drainage and reclamation, swamp lands were granted to certain of the States and about 65,000,000 acres have been patented under this grant.

It is estimated that prior to 30 June 1910 900,000,000 acres, approximately, or the equivalent of 5,620,000 farms of 160 acres each had been disposed of by the government, and there remained approximately 711,986,000 acres, including Alaskan lands, yet to be disposed of. See LANDS, PUBLIC. J. W. WITTEN,

General Land Office, Washington, D. C.

Public Health Association, American. See AMERICAN PUBLIC HEALTH ASSOCIATION.

Public Opinion, the Power of. In attempting to estimate the sources, the power and limitations of public opinion, it is necessary first to determine what public opinion is. Webster defines private opinion as «the judgment or sentiment which the mind forms of persons or things.» More broadly, it may be defined as a conviction based on evidence, an assent secured by argument, or a view acquired, perhaps unconsciously, through the reading habit. Public opinion may be described as the aggregate of private opinion. It is what the mass or the majority believes or feels. A popular government is government by public opinion expressed in elections and formulated in statutes. Public opinion as it regulates the conduct of a community is an unwritten law — a dominant sentiment representing a common agreement or code of morals and manners.

History shows in nearly every age the force of public opinion. In the democratic communities of Greece the great orators Pericles, Demosthenes, and their disciples influenced events through their appeals to the people. In Rome, public opinion was potent, alike under the republic and the empire. Mark Antony's harangue stirring up civil war was to the populace. It was not until the Reformation in England had finally gained over public opinion that it became firmly established. It was responsible for the civil war, for the reaction in favor of Charles II., for the expulsion of James II., his brother and successor, for the selection of William of Orange and the introduction of the Hanoverian dynasty. Public opinion in England forced upon successive Cabinets the necessity for reform of the franchise and of the corn laws. Public opinion directed the Declaration of Independence in this country and sustained the long war for freedom. Public opinion was the prime cause of the unification and emancipation of Italy and of the consolidation of the German empire. Public opinion inspired and carried through the successive revolutions in France in 1789, 1830, 1848, and 1870. In the latter year the fall of the empire and the establishment of the republic was effected by a proclamation in the streets, and without the shedding of blood.

In every state whose system of government is in essence democratic no change of dynasty, of administration, of constitution can be effected that is not directly caused by the operation of public opinion. In modern government public opinion is effective in exact ratio to the freedom of the people. Jefferson called public opinion "that lord of the universe." But it is not lord in Russia, for it is fettered there. Wendell Phillips, at the height of the anti-slavery agitation in New England, said if he lived in Russia he should be an Anarchist, because in that land there was "no free press, no Faneuil Hall, no ballot-box." But in a country like ours, where, as General Grant said, "the will of the people is the law of the land," it is highly important to know what are the creative causes of public opinion. When is it to be followed and when opposed? What is the best method of influencing it? How shall it be directed to produce practical results?

Public opinion as a moral and political force finds its inspiration and its expression in the press and on the platform. Gutenberg was the founder of modern public opinion. The printing press was a most important factor in disseminating the religious views advocated by the Reformers and in thus fashioning a supporting public opinion. The spoken words of Luther reached only the few; printed they reached the many. Thousands of tracts and pamphlets were scattered throughout Germany, carrying the thought-germs of the new religious ideas. With the advent of the newspaper there began to be felt in the world a new power — "the mightiest ever known for the creation, development, and direction of the greatest of modern forces — majority public opinion."

The astute De Tocqueville said: "A newspaper can drop the same thought into a thousand minds at the same moment." But now one newspaper can drop the same thought into a million minds on the same day. In 1900, according to the census of that year, the 2,226 daily newspapers of this country had an aggregate circulation of 15,102,156 copies. The total circulation per issue of all newspapers and periodicals was 114,299,334, and the aggregate number of copies circulated in a year reached the almost inconceivable total of 8,168,148,749. Nearly one thousand of the principal daily papers of the country, with an aggregate circulation of more than 13,000,000, belong to one great news organization — the Associated Press of the United States. They receive the same despatches, covering every habitable quarter of the globe. The same facts, the same condensations of news and views, are "dropped into the mind" of these millions of readers on the same day.

This instantaneous and constant enlightenment of the people as to the affairs of our own country and of the world was what the writer had in view in saying, 10 years ago: "Publicity is the greatest moral factor and force in the universe." President Eliot of Harvard expressed the same view, seven years later, in saying: "Publicity is the great security for democracy, the best weapon against political, social, industrial, or commercial wrong-doing, and in the long run the most trustworthy means of political and social progress." And Justice Brewer, of the United States Supreme Court, in a brief but pregnant statement on "the effect of a free press on American life," written for the New York *World*, spoke of the service of the press "in the evolution of the court of public opinion, that court mightier than any organized tribunal, at whose bar are judged all men, events, and parties."

It is sometimes said by superficial observers that the influence of the press is declining. How can it decline when its character has steadily improved and its aggregate circulation has enormously increased? Have facts lost their power? Does information no longer promote intelligence? Are men less responsive than formerly to sound arguments and sensible appeals? Thirty years ago an eminent bishop of the Episcopal Church said: "It is the press that creates public opinion. It is the grand fact of the hour that popular sentiment has been educated by the press up to the point of spurning party trammels and voting on principle."

If this were true in 1873 how much more universally true is it now! Nearly every great newspaper in this country to-day is independent — financially and politically. The last six Presidential elections have been decided by the independent vote, led by the independent press.

The result of the municipal election in the city of New York in 1903, when the Tammany candidate for mayor was elected by a plurality of 62,000, in spite of the practically united opposition of the press of the city, has been cited as evidence that the newspapers have not the influence commonly attributed to them. It is to be noted, however, that the Democratic majority was reduced one half from that secured in the preceding year; that in the city there are tens of thousands of illiterate voters, who are not susceptible to the arguments or appeals of the press; that an even greater number cannot read, and that a very large proportion of the total number of voters are impervious to argument in an election by reason of their ingrained but honest partisanship or by a selfish interest in the success of the ticket of their choice — as the saloon-keepers and their patrons, the law-breaking classes, the office-seekers, etc. That in a total vote of nearly 600,000, representing a normal Democratic majority of 120,000, a non-partisan ticket needed only 5 per cent more of the vote to have triumphed, is really a tribute to the influence of the press, particularly in the light of the strange mistake made in defying public opinion by strictly enforcing obsolete puritanical Sunday laws which the majority of the cosmopolitan people of the city regard as odious infringements of their personal liberty.

The journalist acts upon and through public opinion, and therefore, from his point of view, the development of public opinion is the central thread of history. It is inseparably connected with the growth of his own profession. History is filled with accounts of wars and their causes, but to the journalist the remarkable point in that relation is the fact that wars used to be made by individual caprice, while to-day no great duel between nations can be begun or carried on without the support of public opinion. For example, in 1870, Napoleon III. and King William were in legal theory the war lords of France and Prussia. Personally they both sincerely wanted peace, yet they could not have it. Bismarck wanted war, and he got it, by manipulating public opinion, which was stronger than the monarchs. He excited the French by permitting the candidature of a Hohenzollern prince for the throne of Spain. Then that was withdrawn and Bismarck seemed checkmated. He and his associates of the Prussian war party, Moltke and Roon, were in despair, when Napoleon III. fatuously helped them by demanding an assurance that no Hohenzollern ever would accept the Spanish throne in the future. Benedetti, the French ambassador, stopped King William on the Parade at Ems to urge this demand, and the king, losing patience, turned his back. The Parisian press raged at this "insult to France," while Bismarck, by some judicious alterations in the despatch in which the king had described this incident, made it appear that the French government had insulted the Prussian sovereign, and the German press was ablaze. Public opinion was roused now in both countries and two almost absolute monarchs were forced to yield to it and go to war against their own desires.

In Morley's 'Life of Gladstone' it is recorded that Lord Aberdeen suffered "incessant self-reproach" for not having striven harder to prevent the Crimean war; and he asked Mr. Gladstone, who was a member of his Cabinet, whether he did not think that he (Lord Aberdeen) "might withdraw from office when we came to the declaration of war," as "all along he had been acting against his feelings." Mr. Gladstone, though sympathizing with Lord Aberdeen's antipathy to any except defensive war, said of the war against Russia: "The government are certainly giving effect to the public opinion of the day."

Many honest Democrats in America, and even some Republicans, doubted the wisdom of opposing secession by war. At the time of his inauguration President Lincoln had no conception of the terrible task before him. He thought in his first call upon the nation for troops that he was going to suppress the rebellion in three months with 75,000 men, an incredible blunder when it is remembered that the total number of men engaged on the Union side during the four years of war became 2,772,408. The press did its duty in that time of danger and doubt. But suppose it had not — suppose it had left public opinion apathetic — would Lincoln have dared to enforce the draft! Would he have dared to call out half the men of military age in the North? Would he have ventured to issue the Emancipation Proclamation? Would he not have offered compromises and concessions for the sake of peace? The public opinion of the North carried on the War for the Union. Lincoln, great genius and matchless leader though he was, was its masterful instrument.

In surveying the growing power of public opinion the journalist must become impressed with a sense of the grave responsibility resting upon all who have any share in the guidance of that mighty force. If he have imagination enough to picture to himself the consequences of inciting national animosities — if he can track reckless words to the grim realities that follow them, on the battle-field and in widowed homes, must he not recoil with horror and indignation from wanton provocation to war?

President McKinley was opposed to the war with Spain, and, mild-mannered as he was, resisted Congress and the popular sentiment as long as he dared. Yet in the end he had to yield his well-known and freely expressed convictions to the demand of the public and the press, while Congress "held a stop-watch" on him to see that the yielding was not delayed. A less striking but still significant example is the historic fact that Mr. McKinley, who as a representative in Congress voted for the free and unlimited coinage of silver in 1877, became the candidate and champion of the gold standard party in 1896, owing to the change of public sentiment on this question in his own State and in the nation.

In our labor wars, too, public opinion presses with a force that is not to be resisted. In the great coal strike of 1902, the operators, the financial interests, the conservative business men, were almost without exception opposed to arbitration. Many appeals to arbitrate were rejected, yet in the end both sides submitted. To what? To the President of the United States? No! To public opinion, whose effective instrument the President was, and whose condemnation neither side dared to face. The President would never have ventured to take the initiative in the unprecedented, extra-constitutional course he adopted if the popular voice had not encouraged him; nor would he have been listened to if he had.

We witnessed in England in 1903, a most remarkable example of the development of public opinion. It was proposed to change the British tariff. Some centuries ago this would have been done by the king or his minister; later by Parliament. Now it was admitted on all hands that neither the king nor Parliament should have the determining voice in the decision. The House of Commons was gagged and the whole discussion was addressed to the people. Mr. Chamberlain resigned his place in the ministry on the ground, frankly admitted, that public opinion at the time was against his policy. The prime minister accepted his resignation with great regret for the same reason. Then Mr. Chamberlain set himself to convert the nation, and we see at this writing going on before us, with no election pending, the unprecedented spectacle of an appeal to public opinion outside of Parliament that may alter the commercial relations of the world.

Ex-President Cleveland has expressed his belief that "as a general rule the influence of newspapers in leading the judgments and determining the conduct of their readers has greatly diminished in recent years." There are more newspapers now than there were 50 years ago, and it is creditable to public opinion if it is unaffected by and even despises the teachings of many of them; for, if it responded to their appeals, its impulses would often be desperately bad — and dangerous to the republic. The influence of partisan and "organic" journalism has no doubt declined — greatly to the advantage both of the press and the country. But to say that the influence of Publicity has declined is equivalent to saying that the sun increases darkness; that facts and truth lose their effect in proportion as they become more widely disseminated.

Editorial influence — the power of the opinions of the paper as distinguished from its news — now depends almost altogether upon public confidence in the honesty, the freedom, the fearlessness and the moral purpose of the journal itself. The people have become very discriminating in this matter. They can detect the advocate of selfish syndicates as well as the equally selfish demagogue and blatant shouter against them. They have shown their appreciation of and confidence in newspapers that are absolutely independent and inflexible in their devotion to what they believe to be right—that "expose all frauds and shams and fight all public evils and abuses" without fear and without favor.

There have been too many notable instances of the influence of newspapers in forming and leading public opinion by their editorial utterances to leave any reasonable doubt as to the continued existence of this power. And this power will persist and increase precisely in proportion to the fidelity of the newspapers to the ideal and the duty of making the press a moral force in the community, serving and battling for the people with entire sincerity, disinterestedness, freedom and fearlessness. The question whether public opinion, however formed and guided, is always to be respected and obeyed admits of but one rational answer. The theory that "the voice of the people is the voice of God" can be accepted only with important reservations. As public opinion is a variable quantity, often, as Jefferson said, "changing with the rapidity of thought," it cannot possibly always be right. Was "the voice of the people the voice of God" when it sustained human slavery in a republic dedicated to freedom? Was public opinion infallible when it sanctioned the instant enfranchisement of a race just freed from the ignorance and barbarism of slavery? Or is it right now in practically acquiescing in the disfranchisement of the same race after a generation of freedom and progress in which their right to the suffrage has been guaranteed by the Constitution? There are often errors of interpretation by those who are most anxious to go with the multitude. Mr. Bryan mistook the hysteria of the Chicago Convention for a cry of the people for cheap money.

No!—nothing is more clear than that it is often the highest duty of the press to oppose public opinion. James Bryce has truly said that "Democracies will always have demagogues ready to feed their vanity and stir passions and exaggerate the feeling of the moment. What they need is men who will swim against the stream, will tell them their faults, will urge an argument all the more forcibly because it is unwelcome."

Public opinion rightly informed is our court of last appeal, and appeal may always be safely made to it against all the public wrongs, official corruption, popular apathy, or administrative faults; and an honest press is the effective instrument in making this appeal.

In the days of the Tweed Ring corruption rioted in the plunder of the city treasury, and as the Ring was in possession of all the administrative machinery and the courts the people seemed helpless. But the New York *Times* exposed the evil with relentless severity, and brought to bear the public opinion that routed the robbers. Tweed died in prison, and his associates sought safety in foreign countries as fugitives from justice. Another notable agitation of public opinion toward the correction of great abuses, the Lexow investigation, was due to the combined endeavors of the whole press of New York city in exposing the infamous condition of our police system.

The Beef Trust, organized to enhance the price of food and thus to enrich a great corporation by the oppression of the people, was exposed and defeated by the appeal of the New York *Herald* to the same great tribunal of public opinion. At a moment when doubt was prevalent and public opinion was peculiarly in need of enlightenment touching dangerous propositions regarding the currency, the *Evening Post* did splendid service in fighting for the maintenance of the gold standard.

Upon the publication of President Cleveland's Venezuelan message, the New York *World* appealed to the good sense of the country against the war spirit which it was calculated to arouse. Opinions were invited and received by cable from the present king of England, from Mr. Gladstone, the Archbishop of Canterbury, and many other dignitaries of the Church and state in Great Britain disavowing any hostile intentions toward the United States and professing the warmest sentiments of kinship and friendship. Public opinion in this country instantly responded to these fraternal expressions, and the talk of war ended in preliminaries for arbitration.

To reveal public opinion, through interviews and special telegrams, and promptly publish it, is one of the most useful functions of the press. In 1895, deluded by the report that a certain syndicate had control of all the gold in the country, the government was prepared to sell to that syndicate its bonds for $100,000,000, at 104½. But a telegram sent by the New York *World* to 14,000 banks, brought 7,100 replies within 12 hours, and more than $235,000,000 in gold was offered to the Government in exchange for its bonds. As a result, President Cleveland annulled the secret contract with the private syndicate and issued a call for popular subscriptions. The entire issue was subscribed for six times over, at a price of about 112, instead of 104½, the syndicate's offer, a gain to the Treasury of more than $7,000,000.

Agitation for a law taxing franchises was begun by the *World* newspaper in the winter of 1899. It tabulated the value of the franchises for the use of the public streets by street railways, gas companies, etc., from which the corporations reaped enormous profits and paid New York city practically nothing. Day after day the facts and figures were printed, showing the magnitude of the injustice. A bill to tax the franchises as property was introduced in the State senate. Petitions for its passage were circulated by the newspaper and received within a week 30,000 signatures. A special train was despatched from New York city to Albany bearing delegates from organizations of workingmen and taxpayers, representing 250,000 citizens and property valued at $80,000,000, to demand a report of the bill from the legislative committee, in which corporation and political influence had tied it up. Many other newspapers of New York came to the support of the movement, and Gov. Roosevelt, as a result of this agitation, gave his official and personal influence in its behalf through a special message to the Legislature, which secured its passage.

Here was a concrete example of a right principle, based on justice and advocated with untiring persistence. It is such agitation as this that informs, arouses and leads public opinion in achieving reforms.

The necessity and the power of persistence and reiteration in attempts to create and to render effective public opinion are not sufficiently appreciated by the press or by individual reformers. To arrest the attention, convince the judgment and enlist the sympathetic support of that great inert mass which we call the Public is a delicate and difficult task. The press, as the chief medium of Publicity, is alone equal to it. And as the press does this work intelligently, conscientiously, courageously — disseminating intelligence as the sun diffuses light — so shall the power of public opinion make for justice in government, for purity in politics and for a higher morality in the business and social life of the nation. JOSEPH PULITZER.

Public Printer. See GOVERNMENT PRINTING HOUSE.

Public, or Common, Schools. The idea of a free public school maintained entirely at municipal or state expense, and altogether under state and secular control is a modern development, which was not realized until the 19th century. The growth of democracy in the last hundred years has been one of the chief causes of the rapid advance of the free and secularized public school system. Only in the United States, however, has the public school system had a development such as a democratic society logically demands.

A system to be truly democratic must have the following characteristics: (1) It must be free to all; (2) it must extend over all stages of education; (3) it must have what is called the «educational ladder»; that is, pupils must be able to pass upward freely from one grade to the next higher; and (4) it must be patronized by all classes of the community.

It may fairly be claimed that the American public school system has now reached a stage where all these ends have been attained. In Germany, in France and until recently, at least, in England, public education has not been and is not even now, generally free, since, though most of the expenses have been met from public or institutional (usually religious) sources, each pupil unless a pauper has had to pay school fees. No educational ladder exists in those countries, for secondary education begins at eight or ten years of age and always in schools parallel to the elementary schools. The pupil who completes the public school at the age of fourteen must go back from four to six years if he wants to have a secondary education. In the United States, however, the pupil enters the high school without loss of time, since the high school begins where the elementary school ends. It naturally follows that in European countries only the children of the «lower classes» attend the elementary schools, and that it is only in exceptional cases that they ever find their way into schools of secondary and higher education. From the beginning, in those countries, the secondary schools, and later the universities, are patronized by the higher social classes, reinforced to some extent by the children of thrifty and ambitious members of the lower ones. In sharp contrast to this state of affairs, it is the proud boast of the American school system at its best, that the public school is open to the poorest and is good enough for the highest; that in form, at least, the system is so organized that the road is open for every child in the republic to carry his mental development to the highest possible point; for not only are elementary and secondary schools free and properly articulated, but in most of the States a free education is offered also in the universities. It is furthermore a matter of daily observation that all classes of our population freely patronize the public schools. The only considerable exception is the private religious, or parochial, school, where the motive for segregation is religious, not social. Nearly 90 per cent of all children of elementary grade attend the public school.

Colonial Beginnings of Public School Evolution.— The beginnings of the free common school reach back to the earliest colonial times. In New England, at least, the predominant motive for promoting public education was religious rather than political. The elementary school of that period quickly merged into the academy or secondary school, where the promising lads were prepared for college. However, the idea that the early education should be free, and in considerable degree compulsory upon all, found early expression. The general court of Massachusetts in 1642 enjoined upon town authorities the duty of seeing that all children acquired at least the rudiments of an education. The order even went so far as to require the removal of children from those parents who persisted in bringing up their offspring in ignorance. The selectmen of every town were further required «to have a vigilant eye over their brethren and neighbors, to see that none of them shall suffer so much barbarism in any of their families, as not to endeavor to teach, by themselves or others, their children and apprentices, so much learning as may enable them perfectly to read the English tongue and (obtain) a knowledge of the capital laws; upon penalty of 20 shillings for each neglect therein.» In 1635 Boston made public provision for the support of a school. The act of 1642 was greatly strengthened by the Massachusetts school law of 1647, which required all towns having 50 householders to «appoint one within their town to teach all such children as shall report to him, to write and read; whose wages shall be paid, either by the parents or masters of such children, or by the inhabitants in general,» and which further required that where any town has increased to 100 families or householders, «they shall set up a grammar school, the master thereof being able to instruct youths so far as they may be fitted for the university.» This law laid the foundations for the present free elementary and the free secondary, or high school, for though it did not insist that all school revenues should be raised by public taxation, it provided that they *might* be so raised, and it made the community responsible for the establishment and maintenance of schools for all its children. In 1638 New Haven set up a school under Ezekiel Cheever, who was paid «out of the common stock of the town.» Rhode Island established a public school at Newport in 1640, and Providence one, 20 years later. In 1633 the first Dutch schoolmaster arrived at Manhattan, when the first school tax, amounting to four pounds, was levied and collected. By 1650 the 800 inhabitants of New Amsterdam paid their schoolmasters regularly from the public treasury. The pay was doubtless meagre enough, but the principle of free public education was in active operation.

More or less rudimentary beginnings of public education are found in the older colonies, as in New Jersey, Pennsylvania, Virginia and the Carolinas. In the South, however, the free school idea was not so hospitably received as in New England and in New York. An oft-quoted expression by Governor Berkeley of Virginia may be cited. When the English Commissioners of Foreign Plantations asked what course was taken in Virginia for instructing the people in the Christian religion, Governor Berkeley replied, "The same that is taken in England out of towns, every man according to his ability instructing his children." He also added, "I thank God there are no free schools nor printing presses, and I hope we shall not have them these hundred years; for learning has brought disobedience, and heresy, and sects into the world, and printing has divulged them and libels against the best of governments: God keep us from both!" So far as Virginia and the remainder of the South were concerned, good Governor Berkeley had his wish, for it was not until after the Civil War that that section of the United States was supplied with anything like a system of free public schools.

The Revolutionary Period.— In all European countries at this period, the financial responsibility for the education of children was held to belong to the parents, so that neither state nor community, religious or charitable organization, ever desired to make education free, except for children of paupers or others unable to meet the expense. The idea that free schools are only for paupers or the very poor, permeated most of the American colonies during the Revolutionary period of American education. Even where the schools were not strictly private, the "rate-bill" for all who could pay was a common device for helping to meet the expenses of the school. This idea prevailed in Pennsylvania, Rhode Island, New York, New Jersey and the South. Some States raised taxes to school the paupers, but they made those pay who could do so. Only in Massachusetts and in the more democratic settlements west of the Alleghany Mountains did the pauper idea of free schools fail to obtain a firm hold upon the people. The fees were collected in various forms.. In cities the assessment was usually in money; in country districts both east and west the rate frequently included a period of board for the teacher, who was thus obliged to "board round" among the families of his district. By 1848 all fees were abolished in Rhode Island. They lasted until 1864 in Vermont, 1867 in New York, 1868 in Connecticut, and until 1871 in New Jersey.

Development of State Control.— From the earliest times in America the responsibility for the support of schools was focused upon the settlement, village or town, never upon the colony, or later upon the State as a political entity. This condition of things lasted well into the first quarter of the 19th century. Since that time, however, there has been a steady advance toward State support, supervision, and control of public elementary education. In no State of the American union has the right to control the public schools been abruptly assumed by State authority; on the contrary, State control has sprung almost spontaneously from natural conditions, chief among which have been the rapid growth of population, and the equally rapid growth of State school funds. The process has been somewhat as follows: As soon as a given State, say Illinois, had at its disposal a considerable amount of money for annual distribution among the school districts, it was natural that the legislature should lay down the conditions with which the districts must comply in order to enjoy such aid. Among the first things prescribed would naturally be (1) a minimum number of days during which the school must be held in session; (2) a course of study that must be taught; (3) the certification of teachers, usually by county authority, but in subjects prescribed by the State. Again, individual communities, however loath to relinquish the management of their own school affairs in their own way, have been obliged to bow to the will of the State, in so far as it saw fit to assert its authority since the power to levy and collect taxes is derived directly from the State. At present all State constitutions contain provisions relating to popular education.

The idea that has everywhere prevailed is that the State should in every way possible stimulate local interest and local effort for the support and improvement of schools, laying its hand of authority only upon those general essentials of the school system which are indispensable to efficiency. This is why the American public school system has manifested such astonishing elasticity. Every community can have as good or as poor schools (down to a certain point) as it desires. The salaries may be high or low, the equipment ample or inadequate, the schools backward or progressive as the community wills. Again, this elasticity is felt also within the teaching body, quite aside from the general tone of the community. It is not uncommon to find public sentiment quickened and elevated by a corps of teachers led by an active and progressive superintendent. The absence of restrictive State control as to subject-matter, methods of teaching, and school organization opens the door to individual initiative, and to consequent progress. The interaction of the two influences, that of the State on the one hand, with its general prescriptions and supervision, and that of the local community, on the other, with its power of adjustment to circumstances, makes the American school system the most perfect adaptation to democratic needs that is to be found in the world. Any civilized European system maintains standards with respect to given particulars that the American public school as a whole can by no means measure up to; but it may be confidently asserted that no European system, however excellent, could, if put into operation in an American State, produce results so wholesome and excellent as those that come from the present system.

The Growth of Public School Funds.— Individual States began at a very early period to establish permanent funds for the support of common schools. In 1795 the lands known as the "Western Reserve," held by Connecticut, were sold for $1,000,000, and the money turned into the school fund. New York also made provision for common schools by setting aside a portion of the public lands for this purpose. New Hampshire began a school fund by exacting one half of one per cent upon the capital of banks within the State. Other States made similar but less effective efforts, a favorite means being the granting of lottery privileges for the raising of funds. Much more fruitful sources of permanent school funds in the several States have been congressional land grants that have been made from time to time out of the unsettled government land lying to the west of the original colonies. Each of the States subsequently carved from this vast territory, received a grant varying from one to three sections from each township for school purposes. In addition to the direct appropriation of land, it has been the policy of the government to turn into the State treasuries, also, a percentage of the net proceeds from the sale of public lands within their borders. In some States, the school lands were sold at an early date at low prices; in others the lands are held to the present day. By act of Congress 1836 a surplus in the United States treasury was distributed among the States. The amount actually given was something less than $30,000,000. In 16 of the 26 States then existing, this money was appropriated in whole or in part to the permanent schools' funds. The present total annual income from permanent school funds and the rent of school lands is something over $10,500,000, but this amount is very unevenly distributed among the States. When we consider that the total annual expenditure for public schools now closely approximates $250,000,000, it can be seen that the income from permanent funds forms but a small fraction of what is actually expended; yet it would be an error to assume that the influence of these public funds has been limited to their comparative magnitude.

Systems of Administration.—Developing as the public school has done from the individual settlement as the starting point, it can easily be understood why the district system of administration has been so potent in the past, and why in some States the people still cling so persistently to this form of management. The "school district," our oldest and most primary form of school organization, is the smallest civil division of our political system. It was early recognized by law and given legal functions and responsibilities. The district manages its school affairs in a simple way, a board of directors or trustees, usually three in number, being elected to employ the teacher, determine the amount of money to be expended, and in general to conduct the school affairs of the district. This is the most elementary and at the same time the most democratic of methods for school administration. It is particularly well fitted to sparsely settled sections of country, but not so well adapted to denser populations, since it prevents the efficiency that arises from consolidation.

The township system forms the next natural stage in the development of school administration, since it is based on a convenient political unit, not too large for effective local direction. In this system, one set of officers conduct the educational affairs of the whole township, erecting buildings where they will best accommodate the people, employing teachers, grading the schools, in many cases providing for the transportation of children to and from school, and usually crowning the whole with a township high school, to which pupils may be promoted upon the completion of their elementary course. The State of Indiana has been a pioneer in introducing the township system. A number of other States have adopted it wholly or in part. See EDUCATIONAL ORGANIZATION: (a) *Township System.*

Most if not all the Southern States have a county system of school administration, because there the county rather than the township is the unit of government. While in the Northern States the county has never been the unit for civil or for educational organization, it is and has long been the unit for supervision of schools. With but few exceptions each county has a superintendent whose chief duties are: (1) the certification of teachers; (2) the personal supervision of the schools through visitation; (3) the conducting of teacher' institutes. See EDUCATIONAL ORGANIZATION: (b) *County System.*

The foregoing organization exists chiefly for the administration of rural and village schools. Nothing has been more marked than the development of cities. It is obvious that administration through the primitive district system would soon become altogether inadequate for the needs of a city. Legislatures have accordingly made special laws to meet the needs of cities of various classes. The largest cities in a State, like New York city, Buffalo, and Rochester, in New York, usually have special charters enabling them to conduct their schools as they deem best. Cities as a rule have Boards of Education for the administration of the system. These boards differ greatly in size and in the manner of their appointment. In most cities the members are elected by the people for stated periods, sometimes at large, sometimes by wards or sub-districts. In some of the larger cities the members are appointed by the mayor and city council acting jointly. See EDUCATIONAL ORGANIZATION: (c) *City School Systems.*

Housing and Equipment.— Nothing is more noteworthy than the development of public school architecture in the United States. In full accord with its democratic genesis, the housing and equipment reflects completely the educational status of the community. The rural school may be a mere unsightly box with the most primitive apparatus; or it may be an artistic building, adequate in size, well heated, lighted and ventilated, supplied with separate wardrobes for boys and girls, and equipped with needed books and apparatus. State and county superintendents have done much to inform their respective rural communities of what is desirable and practicable in country school houses, furnishing freely plans and specifications, and even providing the builders with complete models for their guidance. In the State of Missouri over 600 rural school houses were erected in a short time in accordance with a model furnished by the State Superintendent of Public Instruction. The cost of a building of this type was $600.

The elementary school covering a period of eight years, the most common type of graded-school building in towns and small cities is the eight-room school house,—one room for each grade. The heating, ventilating and lighting of such a building has become an important problem. This problem is rendered much more complex in cities where the plan must be enlarged to accommodate from 1,000 to 4,000 pupils. A typical class room in such a building should be approximately 24 x 32 feet in dimensions, and from 13 to 14 feet in height; it should be lighted entirely from one of its longer sides, the windows reaching to the ceilings; about 2,000 cubic feet of pure warm air per hour should be provided for each pupil; and each room should be provided with a convenient wardrobe. By the use of steam indirect heating, supplemented by «plenum» and «exhaust» fans run by steam or electric power, it has been found practicable to meet the foregoing conditions of heating and ventilating. Practically all of the modern city school buildings secure these most desirable ends. The buildings are usually an architectural ornament to the neighborhood in which they stand. It has gradually come about, therefore, that the public school is one of the best housed institutions of modern society. In the poorer districts of large cities, the school buildings are the palaces of the people; they are moreover the places where the children of the slums find warmth, light, pure air, beauty, and sympathetic humane treatment from their teachers. It is here that their hearts are warmed, their minds developed and supplied with useful and inspiring knowledge; it is here that they are enabled to rise to higher planes of living, and to prepare themselves for a worthier citizenship than their humble origin would seem to warrant. In well-to-do districts of the city, the same beneficent physical surroundings contribute more than any other instrumentality of society to develop the best that there is in democracy. To understand how these forces of the modern school work together to produce the American citizen, the reader is referred to the article by Dr. Wm. T. Harris, U. S. Commissioner of Education. See EDUCATION, ELEMENTARY.

The Sex of the Teaching Force.—For the first time in history, society has, since the beginning of the 19th century, undertaken to educate all its children, boys and girls alike. Before that time only certain classes of boys were educated, invariably by men teachers. With the new duty there appeared a new means, namely, the employment of women as teachers. So long as women remained uneducated, it occurred to no one, least of all the women themselves, that they could teach. So long as they could find productive labor in the home, as they could until steam-power and machinery drove industries to the factory, women felt no especial need of a new calling. But when remunerative labor for women failed in the home, when the schools began to educate them along with their brothers, and when the new social undertaking of universal education began to clamor for more and cheaper teachers, then it was that the world awoke to the fact that it had in its midst a new and hitherto unused force—its young unmarried women. Women began to be employed as teachers in large numbers in the United States before 1850, especially in the New England States, where the first normal schools were established. The period of the Civil War saw a rapid increase, owing to the natural withdrawal of the young men in order to enlist as soldiers. Since the close of the War the percentage of women in the schoolroom has steadily and rapidly increased throughout the Union, until in the cities, at least, men are rarely found as teachers in the grades. They are still employed to some extent in rural schools, especially in the newer States. The following table shows the increase in the number of women teachers in 13 typical States since 1855:

STATES	1855	1875	1880	1886	1902
Vermont	21	85	83	88	82
Pennsylvania	33	50	52	83	87
New Jersey	39	71	76	79	87
Iowa	44	63	67	76	86
Indiana	21	42	48	49	55
Illinois	39	57	61	67	75
Rhode Island	60	80	78	87	91
Missouri	21	39	43	40	66
Connecticut	64	76	76	82	91
Massachusetts	74	88	87	89	91
New Hampshire	74	86	83	88	91
Ohio	46	46	52	56	62
Maine	61	69	67	65	86

The women now number 72.2 per cent of all the teachers in public elementary and high schools of the whole Union, while in city elementary schools they rarely number less than 90 per cent of all teachers. In New York State high schools about two thirds of the teachers are women. The same phenomenon is seen in foreign countries, but the increase in the number of women teachers there has in general been less rapid. In Great Britain and Ireland the increase has been from 54.3 per cent in 1870 to 75.3 per cent in 1900. If one may judge by the attendance at the normal schools, the number of men and women in French elementary schools is about equal. In Germany, as a whole, less than 20 per cent of all elementary teachers are women. In Italy, however, 93 per cent of the students of normal schools are young women, though the women form only about 58 per cent of the whole elementary teaching force. In the 11 State normal schools of Massachusetts there are 117 men, and 1,743, or 93.3 per cent, women students.

The large, almost exclusive, employment of women as elementary teachers is the newest thing in our civilization. It is difficult as yet to interpret its full significance. There is no doubt that society has been well served at very small expense. The economic motive constantly appealing to communities that do not like high taxes is that they can get better teaching from women for a small sum than they can from men. A first-class woman teacher, they say, is always to be preferred to a second-rate man at the same salary. The assumption is that vigorous, active, well-prepared men can do better financially out of than in the school, and that only second-rate men will accept women's salaries. Ultimately, if the feminization of the school should prove not to be for the best welfare of society, it is pretty evident that the additional cost will not prevent the employment of a suitable number of men. The public school system may be said to be now in its «brick and mortar» stage, for it is expending vast sums to house and equip the school. When this has been done, the resources of the community may easily be turned to the improvement of the teaching force. President

Eliot of Harvard University argues that the people ought not to spend less upon the minds of their children than they do upon their food. Were this standard attained, it is probable that school support would be quadrupled. So far as present experience teaches, it seems evident that for the first four or five years of school life women are the natural and the more efficient teachers. When it comes to the early years of puberty, society still holds theoretically that the influence of men is essential to the proper unfolding of the minds and characters of both boys and girls. It is this conviction which, for the most part, enables the non-sectarian private school to maintain its existence in the more wealthy communities. It is probable, notwithstanding the aforementioned theory that men are indispensable as teachers of youth, that the availability of women and the difficulty of holding the right type of men in such positions, will confirm the present custom of almost exclusively employing women for grade teaching.

The Development of the Public School Curriculum.— Down to 1837, when Massachusetts created her board of education and placed Horace Mann at its head, the curriculum of schools not fitting boys for college was limited to the bare acquisition of the school arts, spelling, reading, writing, ciphering, relieved by a trifle of geography and history. The discipline was always rigid and sometimes harsh; the school term was short and the years of schooling few; the path of learning was not strewn with roses; but the intellectual, like the moral, discipline did honor to the straitest notions of our Puritan forefathers. In his seventh annual report, Mr. Mann, who had visited schools abroad, especially in Germany, where the new philosophy of Pestalozzi was earnestly applied, attacked with great vigor the old curriculum, the old Puritanic ideals, and the old unsympathetic methods of teaching. He demanded new subjects more suitable to children, more humane and sympathetic treatment of pupils, and new ideals of the ends to be attained by education. These criticisms and demands led to a spirited battle between Mr. Mann and his admirers and the «Thirty-one Boston Schoolmasters,» who defended the old-time rigorism in study and discipline. The result was a drawn battle. The reformers succeeded in getting their ideals and watchwords accepted, but the conservatives preserved the old curriculum practically unchanged. It was, however, a great advance to have the new ideals of character-forming accepted as a supreme end of education. Even if the school were to be confined to the acquisition of the school arts, it was a vast improvement to have the new methods everywhere put into practice, for now the concrete was made to precede the abstract, facts came before principles, and inductive reasoning enlivened and enlightened the old-time memory drills and mechanical application of rules. The school term was gradually lengthened, and with this there came a perceptible thought-enrichment of the studies by means of which the children were drilled in the use of the tools of knowledge.

This condition of things lasted until after the period of the Civil War, when the rapid development of the public high school, the still more remarkable expansion of the university curriculum, and the rise of all sorts of social organizations for the moral and economic welfare of the community, forced upon the public school an amount of new subject-matter that is little short of astounding. As already explained, the old curriculum was mostly confined to the studies through which the child was drilled in the use of the school arts. The children learned to read, but they never read anything; they learned to spell and write and parse, but they produced nothing more than an occasional school essay. But now behold how this old course of study has been «enriched!»—(1) by copious amounts of literature suitable to every grade, not only in the elementary but in the high school as well; (2) by systematic «language lessons» throughout the full course; (3) by the occasional introduction of elementary algebra and concrete geometry in the seventh and eighth grades; (4) by four years of history and as many of geography; (5) by nature work in all the grades; (6) by a course in manual training or «occupations» throughout the whole elementary period; (7) by extensive acquisition in fine arts, such as drawing, painting, molding, and music; and finally (8) by an obligatory course in physiology and hygiene, accompanied by what is called scientific temperance instruction.

The foregoing may be called reform by addition. Heretofore the method of relief from a congested curriculum has been by subtraction. When the «reform» forces of a community have been in the ascendency, the new subjects have been added; when, on account of complaints of taxpayers, parents and children, the wave of reform has receded, the new subjects, then called «fads,» are dropped, and the curriculum assumes something of its old-time proportions. Obviously some method better than that of addition and subtraction is needed for overcoming this obtrusive dualism in the course of study. That of organization has been suggested by Prof. John Dewey, whereby the school arts shall be made to emerge from the acquisition of extensive bodies of life-giving knowledge. To effect this reform, however, teachers must be better trained, school facilities must be increased, and, most important of all, teachers must have smaller classes. The ideal public school of the future will not require one teacher to teach more than 20 children. Now the number often rises to 60.

For statistics of the public school, see EDUCATION, ELEMENTARY.

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Public Utilities. The drastic regulation of public utilities is becoming the policy of an increasing number of States. The day of commissions, clothed solely with the power to recommend and not enforce, is of the past. During the last few years, the idea has gained wide acceptance that a public service corporation, which owes its existence to the State and thrives upon a franchise given by the State or local governments is not a private business, and should, therefore, be subject to government regulation in so far as its dealings with its patrons and the general public are concerned. During 1910, Maryland and New Jersey, following in the wake of New York and Wisconsin, created public utility commissions. In Maryland, there is the court review provision to be found in the Wisconsin law. The New Jersey act gives the commission jurisdiction over telephone companies as well as all other public utilities. It even makes the granting of franchises dependent on the approval of that body. There were important changes made in the public utilities law of New York. The jurisdiction of the commission was extended over telephone and telegraph companies and the commutation rates of railroads. This extension of power had been asked for by Governor Hughes at the 1909 session, but it was not until the next one that it was granted. Telephone and railroad commutation rates have long been a matter of dispute in New York, and this largely inspired the governor to recommend that the Public Utilities Commission have jurisdiction in the matter.

The Public Utilities Law of New York went into effect on 1 July 1907. It was the first important measure asked for by Governor Hughes and only passed both houses of the Legislature after a spirited contest in which the Governor himself took part, by arousing public sentiment in the subject. No better explanation of the reasons for the law has been given than that of William M. Ivins, the special counsel for that body in the first district. In an article in *The Century,* he stated that the act was intended to accomplish the following: (1) To prevent wrongs in over-capitalization, and in the issue of corporate securities; (2) to prevent monopoly by making it impossible for one corporation to hold more than than 10 per cent of the stock of another; (3) to secure the efficient control of corporate accounting, bring about publicity on the subject and end the practises of public service corporations of keeping books that fail to represent their true condition; (4) to compel an adequate and honest product at fair and reasonable rates, without discrimination among users or consumers; (5) by investigation, to throw the light of publicity on the operation of those kinds of business which the interest and welfare of the community is a primary consideration; and (6) to secure the safety of the general public. Under the New York law, there are two commissions: one for Greater New York, the first district, the other for the rest of the State. The original act placed all transportation, gas, and electrical companies within the borders of the State under the jurisdiction of the commission. It has the power to make their rates reasonable, and prevent discrimination. The safety and adequacy of the service are also within the jurisdiction of the board. It also may require that the accounting methods of public service corporations be uniform and the books kept so as to reveal their actual financial condition, and that their capitalization represent present values instead of future. A most important work of the commission for Greater New York has been the laying out and construction of the subways under contemplation. More than half the time and 70 per cent of the expenditures of the commission have been devoted to it. The commission in the First District has been giving consideration to 10,000 complaints annually. The method of procedure in such cases is simple. Every complaint received is acknowledged and forwarded to the company against which it is made with a request that the cause be removed within 10 days or an explanation sent to the complainant and the commission. If the explanation is not satisfactory, the matter is investigated by the experts of the commission. Upon their report, recommendations are made. This, however, is often only a preliminary step. For if any side should be dissatisfied with the recommendations, a hearing must be held. Where the matter is of great importance, the hearing is public. The commission then renders final decision. It will either dismiss the complaint or serve an order on the company to comply with it, which order also gives a time limit. The penalty for disobedience may be as much as $5,000 a day in the case of a transportation company, and $1,000 for a gas and electric. Of the complaints received, one-third are usually settled amicably. In about one-quarter of the cases, they are usually found to be trivial or baseless. Many of the complaints considered in the First District related to the overcrowding in the subway. The experts of the commission made an investigation. An important result was the lengthening of the station platforms to enable the running of more trains. Some minor orders on the subject were the providing of guards to help load and unload the cars, side doors on express trains a speed control at express stations in order to allow the trains to follow each other with greater rapidity and better electric light for the illumination of the cars. For the prevention of accidents, the surface cars were ordered equipped with fenders and wheels guards of the type found by experts to be the most effective. As a result, whereas for 1907-08, 508 persons were fatally injured by the roads, the figures for the following year showed a decrease of 128, or 30 per cent less. A most important work of the commission in the First District has consisted in passing on applications of corporations for the issuance of securities. An early one was that of The Interborough Rapid Transit Company. It asked leave to execute a mortgage for $55,000,000 in order to pay certain notes then coming due. The commission granted the application, upon the company including in the mortgage its interest in the elevated railways as well as the subway. When the Coney Island and Brooklyn railroad made application to issue bonds for $372,000 in order to make certain improvements, the commission made an investigation and found that a large part of the funds were to be used for mere replacements instead of actual improvements and only to offset depreciation; that this depreciation should be met by a fund created from annual earnings. It finally allowed a bond issue of $107,000 and ordered that the bonds be sold for not less than 80.

The Wisconsin law differs from the New York law in two features. It requires the commission to value all the property of every public utility actually used and to publish the value of the physical property along with the value of all the property. It also places plants owned by municipalities under the same regulations as those of private corporations. Their method of accounting is the same and they must go to the commission if they desire to raise rates. The physical valuation is the most important feature of the Wisconsin act. For this purpose, there is a staff of scientific investigators required to investigate and ascertain for each public utility what is the reasonable value of the service it renders to the public. The company is obliged to submit all its evidence to that body and only on what it submits can it go into court and seek a review of the findings. No settled rules of evidence guide the commission in its work It can consider any document, writing or statement that bears on the subject. An important decision on the subject was the overruling of the contention that value meant power over others and was based on stocks, bonds, or capitalization of net earnings. Like the New York body, the commission has paid much attention to gas meters, with the result that they are now on a more accurate basis.

Public works, School of. See POLYTECHNIQUE, THE.

Publicani, pŭb-lĭ-kā'nī, Roman farmers of the public revenues. In ancient Rome the privilege of collecting revenues from foreign districts dependent upon Rome was sold at auction by the censors for a period of five years. The security required by the state from these taxgatherers was usually the price at which they had purchased the branch of revenue to be collected and frequently was far in excess of the wealth of any single bidder, which resulted in the formation of companies for the purpose, called Socii. Their business with the state was conducted under the name of one member designated the *manceps*. The farmers of the revenue were of the wealthiest classes. None but Roman citizens could be a member of the publicani and magistrates and governors of provinces were not eligible. The revenues were derived principally from tolls, tithes, mining duties, and *scriptura* (tax levied for the use of the public pasture lands). The collections were made by an inferior class who were often freedmen or slaves in the employ of the company and were cordially detested by populace. The high price paid for the privilege and the greed of the publicani resulted in great injustice which together with the character of the collectors explains the bitterness with which they are mentioned in the New Testament. From about 150 B.C. they were usually of the equestrian order.

Publick Occurrences, the first newspaper published in America, though it can hardly be called a newspaper, as no second number appeared. It was issued at Boston in 1690 by Benjamin Harris and printed by Richard Pierce. See AMERICAN NEWSPAPERS.

Publicola, pŭb-lik'-ŏ-la, **Publius Valerius,** Roman consul and general: d. between 503 and 496 B.C. He was instrumental in the expulsion of the Tarquins, and when Collatinus was forced to resign Valerius was elected consul in his stead in conjunction with Junius Brutus. When the Tarquins, aided by the Veientes, moved against Rome in 509 B.C. they were met by the Romans under the two consuls and defeated. Brutus fell in the battle leaving Valerius sole consul. He promulgated a law by which any person who attempted to usurp kingly power might be killed by any one, and another establishing the right of a plebeian condemned by a magistrate to appeal to the people. In recognition of his services he received the surname publicola, «the people's friend.» He was three times re-elected consul, conducted the expedition of Porsena, and with his colleague Titus Lucretius Tricipitinus defeated the Sabines in 504.

Publishing. See AMERICAN PUBLISHING; BOOK.

Puck, in mediæval mythology, a celebrated fairy whose character and attributes are depicted in Shakespeare's ‹Midsummer Night's Dream.› This fairy is known by a variety of names, as Robin Goodfellow and Friar Rush in England, and in Germany as Knecht Ruprecht; but it is by his designation of Puck that he is most generally known in England, Germany, and the more northern nations. He was the chief of the domestic tribe of fairies, or «brownies,» as they are called in Scotland and innumerable stories are told of his nocturnal exploits.

Pud. See POOD.

Pudding-Berries, the berries of the Canadian dogwood (*Cornus canadensis*), common throughout North America. See DOGWOOD.

Puddingstone. See CONGLOMERATE.

Puebla, La, lä pwāb'lä, Mexico, a State of the Republic and its capital city. The State of La Puebla in the central plateau of the Anahuac has Vera Cruz to the north and west of it, Oaxaca to the south, Guerrero to the southwest, and Morelos, Mexico, Tlaxcala, and Hidalgo to the west. See MEXICO — STATE OF.

Puebla, Mexico (originally called Puebla de los Angeles), capital of the State of the same name; 116 miles east of the City of Mexico by the Mexican railway, but considerably less than 100 miles in a straight line; altitude over 7,000 feet above the sea. The climate is most agreeable, the maximum temperature being 84° in summer and 75° in winter. The peaks Popocatepetl and Ixtaccihuatl are only about 25 miles distant, and those of Orizaba and Malinche are in plain view. Three steam railways,— the Mexican, the Mexican Southern and the Inter-oceanic, and a street railway which will soon be electrified, supply transportation. Straw hats, leather goods and numerous other articles are manufactured in considerable quantities, and in the immediate vicinity are several large cotton mills. Near by are the famous onyx quarries which have for many years supplied great quantities of beautiful onyx to Mexico and the United States. A manufactory in the city makes of the product of these quarters an endless variety of useful or ornamental objects, from store and saloon fixtures, table tops and wash basins to imitations of every fruit known in the country. The banking facilities of the city are supplied by the Oriental Bank, with $6,000,000 capital, and branches of the National Bank and Bank of London & Mexico, of Mexico City. The city is noted for its many churches, clean streets, substantial business edifices and grand Cathedral, which was almost 150 years in building, is 323 feet long, 101 feet wide and 80 feet from floor to roof.

The educational institutions besides the Primary and High Schools, are the State College, School of Medicine, Normal School for Men, Norma School for Women, Normal School of Arts, Academy for Belles Arts, and Hospicio for the education of children. There are three public libraries with a total of 78,000 volumes, a museum of archæology, an art gallery, an observatory, a market hall, sulphur baths, a general hospital founded in 1658, and a maternity hospital, state hospital for both sexes, hospital for the insane, children's hospital, military hospital, Interoceanic Railway Hospital and Spanish Beneficiary Hospital. The Palace of the state government, which was recently greatly extended and improved and which faces the principal park or zocolo is one of the notable buildings of the city. The extensive and very beautiful Alameda is a most attractive spot, and contains a monument erected in 1898 in honor of Mexico's liberators, and the monument to General Nicolas Bravo. There are also the French-Mexican monument erected by the French colony in 1902, and the equestrienne statute of General Zaragoza, which surmounts a fine monument erected at the foot of the hill of Guadalupe. In the Government Palace is a most interesting collection of historic paintings and a library of 28,000 volumes. The zocolo or central park of the city is artistically laid out in vine and foilage covered walks, with fountains and statues here and there, and numerous small plazas supply needed breathing spots. There are two theatres. Since 1532, in which year the royal sanction was given to form a settlement here, Puebla has occupied second place among all the cities of the land, commercially, spiritually and in population, until very recently, when Guadalajara forged ahead in population and material development generally.

The city of Puebla was founded in 1532 by the Franciscans, and is considered the military key to the capital of the republic. It was captured by the French in 1863 and recovered by the Republican forces under General (now President) Diaz, in 1867. Tradition asserts that when Cortez came he found a city of 300,000 inhabitants, 400 temples and a legion of priests, six miles distant from Puebla, where now is the famous Pyramid of Cholula; and that the Aztecs came there in great numbers to worship and offer up human sacrifices. Pop. about 100,000.

Pueblo, pwĕb'lō, Colo., city, county-seat of Pueblo County; on both sides of the Arkansas River, at the mouth of Fountain Creek, and on the Atchison, T. & S. F., the Colorado & S., the Denver & R. G., the Missouri Pacific, and the Chicago, R. I. & P. R. R.'s; about 122 miles south by east of Denver. Within its corporate limits are several villages: North Pueblo, Central Pueblo, South Pueblo, and Bessemer. It is in a basin on the eastern foot-hills of the Rocky Mountains. A temporary Mormon settlement was located here in 1846, and a trading post was established in 1850. In 1854 the Ute Indians massacred the residents of the post. In 1859 the present city was laid out, and in 1873 it was chartered as a city. The region of country east is largely devoted to agriculture and stock raising. In the vicinity of the city are extensive coal and oil fields, and deposits of limestone and iron ore. The silver and copper ores are brought a considerable distance to the smelters of Pueblo; and lead, gold, and zinc are here prepared for the metals of commerce. The iron and steel industries have become quite extensive. The Colorado Fuel and Iron Company (steel plant) have (1904) 6,300 employees; the railroad car-shops and yards, 2,500 employees; the smelters, 3,200; the foundries and other manufactories, 6,000. In 1903 there was invested in manufacturing industries, a capital of about $13,000,000, and the products were about $32,000,000, of which amount nearly two thirds was the product of the lead smelting and refining.

The principal public institutions are the State Insane Asylum, Saint Mary's Hospital and Sanatorium (1,000 patients annually), Minnieque Hospital (cost $300,000), and small private sanatoriums. There are two systems of public schools, one on each side of the river; two high schools, public and parish schools (14,000 school children), Loretto Academy, the McClellan public library with 14,000 volumes, law libraries, school libraries, and the State Mineral Palace and Park. A complete collection of the minerals of Colorado are in the Mineral Palace. The five banks have a combined capital of $800,000 and deposits of $10,000,000. The government is administered under a charter of 1887 which provides for a mayor who holds office two years, and a council of eight members. The council confirms the mayor's appointments and elects the police judge, city physician, and the members of the fire department. The treasurer, clerk, engineer, and auditor are elected by the people. The city owns and operates one system of waterworks, and another is owned by a private corporation. The large majority of the population are native-born Americans; about 2,000 are Italians; 1,000 are Austrians, and 1,500 are colored. Pop. (1890) 24,558; (1900) 28,157; (1910) 44,395, an increase during the last decade of 57.7 per cent. E. W. POERRE,

Secretary Business Men's Association.

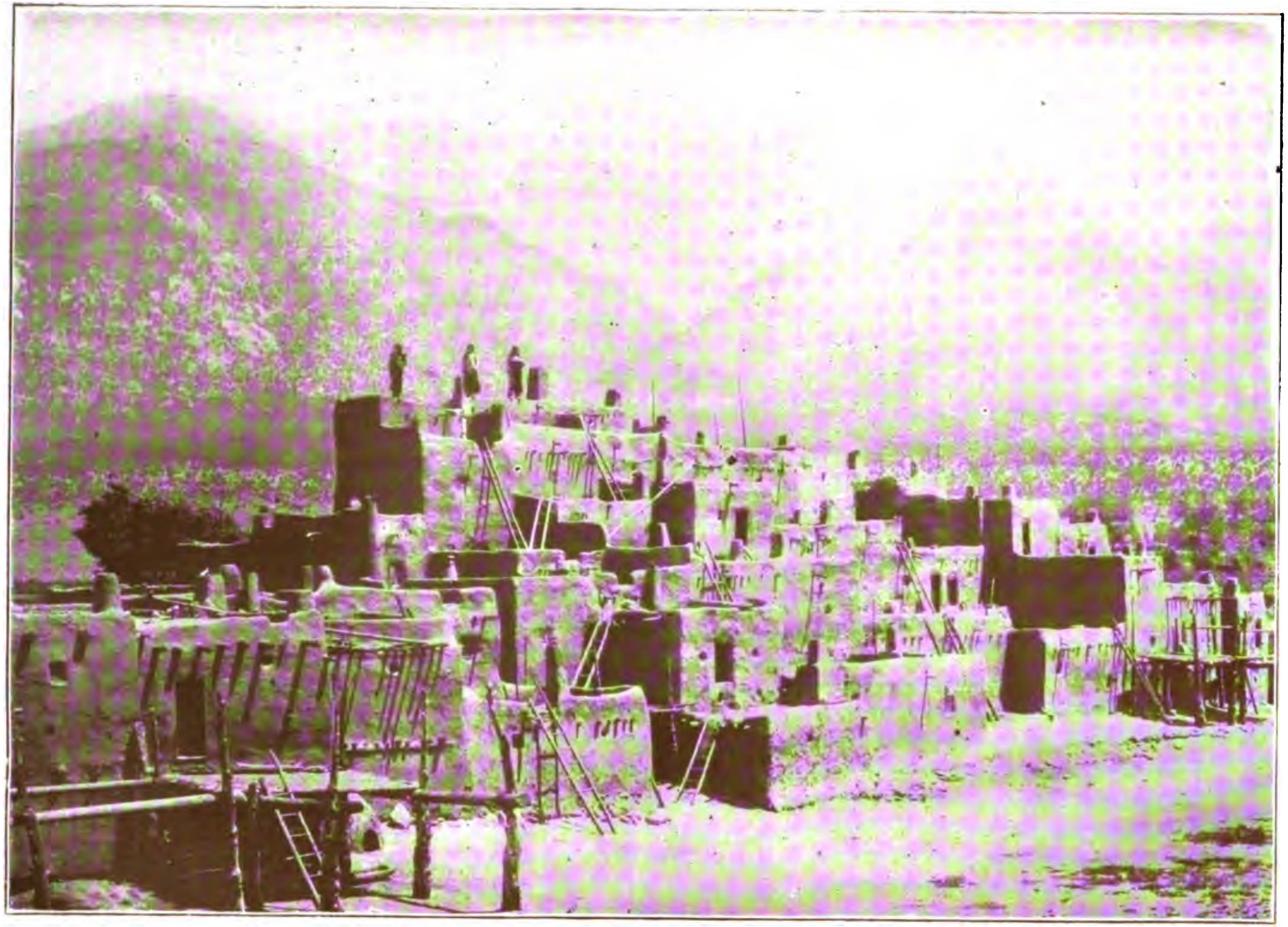
Pueblo Indians (Spanish, «town,» «village»; hence Pueblos, «villagers»), a group of sedentary agricultural tribes comprising the Tanoan, Keresan or Queres, and Zuñian linguistic stocks in New Mexico, and the Hopi or Moqui of the Shoshonean stock in northeastern Arizona. There are also some Mexicanized remnants of the Tanoan stock on the Rio Grande below El Paso, in Texas, and Chihuahua. For details see under the above stock names.

Physical Characters.—Disregarding those who have been more or less affected by Spanish contact, the Pueblo Indians are generally small in stature, particularly the women, some of whom are quite diminutive. After marriage the latter frequently become stout, but obesity is rare. The men are a rich brown in color, not so dark nor so reddish as their Navaho neighbors. The women are lighter, many of them being of a fine olive tint, which, with regular features and often with eyes almost oriental in type, make them decidedly comely. Albinism is common among the Hopis and Zuñis, those of the latter tribe averaging one in 200. The hair is thick, black, and glossy. That of the men is cut «terrace fashion,» that is, banged across the forehead, cut horizontally at the sides on a line with the chin, and allowed to grow to full length behind, but knotted and tied into a short queue. This is probably the more primitive style of hair dressing, but it now varies more or less with the tribe. The front hair of the women is cut level with the chin, parted laterally, and allowed to fall over the face, necessitating continual brushing aside with the hand to permit them to see. The unmarried Hopi girls retain the primitive method of wearing the hair, after reaching puberty, in large whorls over the ears.

Dress.— The costume of the men, now largely superseded by the clothing of civilization, consisted of a shirt, a poncho-like coat formed of a squarish piece with a hole in the middle for the head, and sewed down the sides, with partly open sleeves; a pair of loose trousers reaching below the knees, open half-way up the outer sides and fastened with a belt; footless stockings, leggings, garters, moccasins or sandals, breechcloth, headband, hairband, and blanket. Dressed skin or native cotton formed the chief materials from which their costumes were made, but these gave place largely to woolen articles after the introduction of sheep by the Spaniards. The woolen blanket of later times was probably preceded by a robe made of strips of rabbit or wildcat skin coarsely woven or plaited together. Yucca strips, feathers, and even human hair also formed raw materials for clothing. The typical dress of the women consisted of a skirt of skin or cotton (now of wool) reaching from the neck to below the knees, and girded with a belt, the right arm and shoulder being bare; a manta hanging loosely from the neck and down behind or thrown over the head; stockings, buckskin leggings, consisting usually of an entire skin wrapped many times around the calf, and sandals or moccasins, to which latter the leggings were attached. Among some of the Rio Grande Pueblos the women wear soft buckskin boots instead of the cumbersome leg-wrappings. Necklaces of seashell and turquoise beads and pendants, ear-tablets, bracelets, and other ornaments were worn by both men and women, but the shell necklaces of the latter have been superseded by those of silver. Leather belts strung with large silver disks and silver-mounted wristguards are now worn by the men who can afford them. Excepting the moccasins and leggings, skin has largely passed out of use for clothing, cheap cotton prints and a woolen blanket being almost exclusively employed by the men.

Houses.— The typical pueblo is a many-celled, communal, defensive structure of several stories, opening on one or more courts or plazas in which dances and other ceremonies are performed. When the pueblo enclosed a single court, the outer wall was usually the highest, and was pierced with only small openings, or port-holes, to afford a view of the surrounding country. A slight elevation was usually preferred, but there are many instances in which the site is a lofty mesa or a level plain, while other dwellings were built in natural recesses in the rocky walls of cañons or cliffs, hence their popular designation, *cliff-dwellings.* The site therefore depended on accessibility to water, to cultivable fields, or to the necessity for defense against enemies. Both rounded or polygonal structures were common, while some pueblos were semicircular in ground-plan, with a high rear wall and with the houses arranged in terraces, the tiers of dwellings successively retreating so that the roof of the lower formed the means of access as well as the «front yard» of the tier next above, and so on to the sixth or seventh story. The ground tier usually contained only small wall openings, access being gained by means of a movable ladder to the roof, which was provided with a hatchway. Most of the pueblos still follow this ancient form, but there are now but few whose ground-floor houses are not provided with doors and windows. Sometimes forming a part of and sometimes detached from the main house cluster, are chambers, wholly or partly under ground and usually circular, used as gathering places and sleeping apartments by the men, and still employed for ceremonies and tribal councils. The fireplace was in the centre, the smoke escaping through the hatchway; so hot did these *kivas* become that the Spaniards likened them to stoves, hence their still popular name, «estufas.» The structural materials depended largely on the immediate supply. Slabs of sandstone being abundant, were commonly used; they were sometimes neatly pecked and laid in adobe mortar or chinked with spalls, and although joints in the masonry were not «broken,» the result was frequently a marvelously straight and strong wall that has stood the ravages of centuries. *Pisé* construction was also employed in massive buildings, such as Casa Grande in southern Arizona. Molded adobe bricks, now so commonly used, were not made in pre-Spanish times, but balls of mud mixed with ashes and sage, and dried, were in vogue as a building material in prehistoric times. The roofs of the houses consist usually of pine or cottonwood beams, with light poles laid transversely, which in turn were covered with brush-grass, and adobe mud, well tamped. The introduction of the horse, which permitted the transportation of heavy roof beams, seems to have had a decided influence in increasing the size of the rooms, the compartments of the ancient structures being usually mere cells. Flakes of selenite were pieced together for window panes, but these have given way to stock frames purchased from the white traders, while the corner fireplace and chimney have been substituted for the central fire pit, except in the kivas.

Industries.— As they are sedentary tribes, the Pueblos are agriculturists, their principal crops being corn, squashes, beans, and onions, to which were added wheat, watermelons, cantaloupes, grapes, peaches, etc., on the advent of the Spaniards. Corn is prepared in very many ways, and wild fruits form a not unimportant part of the Pueblo pabulum. Their meat supply was gained mainly through communal hunting, the mountains supplying bear, deer, antelope, and elk, while the valleys and cañons abounded in jack-rabbits, cottontails, prairie-dogs, wild turkeys, quails, doves, etc. The buffalo was probably hunted to some extent by the Rio Grande Pueblos, who also conducted a brisk trade with the Plains tribes up to 25 years ago. For religious reasons, fish was probably universally tabooed, water, on which everything depends, being a sacred element. The turkey was domesticated,



PUEBLO INDIAN VILLAGE.

and eagles were and still are kept in captivity for their feathers. Cattle, sheep, goats, horses, and asses, which now form such an important part in the Pueblo economy, were unknown before the Spaniards went among them. The Pueblos are a provident people, their reserve food supply usually being sufficient for a year's use, thus succoring them in event of drought. Most of their agriculture is conducted by means of irrigation, although patches of corn, melons, squashes, etc., and small peach orchards are otherwise successfully cultivated in favorable localities. The Hopis raised large quantities of cotton, which they wove into garments and traded with other tribes; indeed they are still the leading cotton weavers among the Pueblos, the industry probably having been introduced by clans from the far south. The Hopis and Zuñis also weave excellent blankets, sashes, dresses, garters, etc., of wool, and a few of the Zuñi men are expert silversmiths. The basket trays of the Hopis are noteworthy, although the art has greatly declined since the introduction of aniline dyes. Some of the other Pueblos make a coarse basket for domestic use. As potters the Pueblos are far in advance of all other Indians north of Mexico: purely primitive methods are still employed and the decorative motive is generally symbolic, intricate, and pleasing.

Social and Religious.— All the Pueblo tribes are composed of numerous clans, named after some animal, plant, or other natural object, and grouped into phratries. Maternal descent is recognized, that is, the children belong to the clan of the mother. Marriage, which is not allowed between members of the same clan, is generally effected by mutual consent of the contracting couple and their parents, and is sealed after an exchange of gifts and a simple primitive ceremony; the vow, however, is not very binding, and divorce is merely a matter of mutual agreement, the offspring, if any, invariably belonging to the mother. The status of the Pueblo woman is high; she owns the house and its furniture, while it is the husband's duty to provide for his family and he frequently makes his wife's clothes. The dead were formerly buried in the houses or beyond the house walls, according to the priestly standing of the deceased; now, however, the dead are buried in a common cemetery in front of the Catholic Church, except among the Hopis, who deposit their dead in crevices in the rocks. The social and religious organization of most of the Pueblos was considerably affected by the Spanish missionary and civil authorities, and among all the tribes except the Hopis a civil governor and other officers are now annually elected, although their power in some instances is only nominal. Originally the religious and social organization was inseparable: each clan had its priest or priest-chief, while both the internal and the external affairs of the tribe, where they affected the complicated and far-reaching religious organization, were controlled by a priesthood. There were also other socio-religious societies, grouped according to the several regions — north, south, east, west, upper, and lower — some of which assumed control over certain affairs in winter, others in summer. The members of these societies, where they still exist, are the medicine-men of the tribe, some of whose functions are the prevention as well as the cure of disease, the regulation of the communal hunts, the extermination of witchcraft, etc., and the intermediation between the tribesmen and the many nature gods which form the Pueblo pantheon. Communication with these nature powers was and is still conducted by means of secret or open ceremonies, consisting of the depositing of prayer-sticks, chants, dances, sacrifices, pantomime, masquerade, the recital of rituals, etc.

History.— From the Pueblo tribes which have been more intimately studied it has been learned that they consist of many small accretions from various stocks and from many localities, which left their former homes on account of drought and the consequent failure of crops, through superstition, the depredations of enemies, etc. The migrations of these component clans or parts of clans were sometimes very slow, many years being consumed in their journeyings and village after village being successively built, occupied, and abandoned before the final settlement was made. Thus are many of the ruins of Arizona, New Mexico, Colorado, and Utah accounted for. The nuclei of the various Pueblo tribes, however, had their traditional origin in the north, at a place called Sipapu, where they are supposed to return after death, and which is symbolically represented by an opening in the floor of the ceremonial chambers, in front of the altars erected during religious rites.

Indefinite knowledge of a populous region in the north was gained by the Spaniards in Mexico early in the 16th century, and led first to the journey in 1539 of Fray Marcos de Niza to the «Seven Cities of Cibola,» the present Zuñi, followed a year later by the expedition under Coronado. This was the first direct contact of the Pueblo Indians with the whites. For the successive Spanish expeditions and the later history of the Pueblos, see NEW MEXICO, and also the subjects mentioned below.

Population.— At the time of Coronado's visit the Pueblo tribes were said to inhabit 66 villages and to number 20,000 men, but it is doubtful if the entire population exceeded this estimate. With the exception of Acoma and Isleta none of the 28 pueblos now existing occupy their 16th century sites, the remainder having been forced into new locations chiefly during the reconquest of New Mexico after the Pueblo revolt of 1680. The present aggregate population of the 28 villages is 10,259. For their distribution see QUERES, SHOSHONEAN, TANOAN, and ZUÑIAN.

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Puer'peral Eclampsia, a form of eclampsia occurring in pregnant women, usually arising from blood-poisoning and often fatal. The exciting causes may be many, but some form of increased irritability of the nervous system is one of the most important features of the condition. The symptoms come on suddenly, or following a headache, with irritability, and perhaps slight impairment of sight or hearing, or with vomiting. Convulsions of an epileptic, hysterical, or apoplectic variety constitute the main symptom. These convulsions may last for from one to five minutes, and are usually accompanied by unconsciousness. They recur sometimes at very short intervals, most frequently hourly, and many vary from 10 to 30 or more in a day. Such convulsive seizures are always serious to both mother and child, and prompt emptying of the uterus is the main remedy to be employed.

Puerperal Fever, an infectious disease of women occurring shortly after childbirth, or following a miscarriage, accidental or induced. It is caused by a micro-organism, usually a bacterium (*Streptococcus*), and is communicated by contact with unclean hands, instruments, or clothing which may have brought the infection, just before, during, or after the birth of the fœtus. Only in the rarest of instances does it occur when due precautions as to absolute surgical cleanliness have been observed. It usually begins within a week after the termination of pregnancy, ordinarily from the third to fifth day, and is attended with acute inflammation of the reproductive organs, and with septic infection of the blood and body at large. It is always an infection from without, and is preventable by rigid aseptic midwifery. The symptoms will vary very widely according to the infecting organism and the severity of the infection. A slight amount of fever and some local extension of tenderness may be the only symptoms present in mild cases. In septicæmic cases there is usually a decided chill about the third or fourth day, and is attended with acute inflammation of 102°, 103°, 104°, 105° F. with general depression and rapid pulse. The temperature usually remains high and then suddenly drops as the patient recovers. In the severest cases, the pyæmic infections, the blood-current becomes infected; chills, temperature, sweats, occur and recur, and the patient usually dies. The treatment is purely medical, sometimes surgical, and needs the skilled physician and nurse. Prevention is the demand of the modern woman, and she is entitled to it. Unskilled and dirty midwives, unclean doctors, and abortionists are responsible for practically all of the deaths due to childbed fever.

Puerto Cabello, pwär'tō kä-bĕl'yō, Venezuela, port and capital of the state of Carabobo, on a low peninsula jutting into the Caribbean Sea and forming one of the finest harbors in the world. A lighthouse and fortifications protect the entry. Railroads connect the city with Valencia, 22 miles southeast, and with Caracas, 78 miles east. German commercial interests here are strong. The exports are coffee (six sevenths of the whole), cacao, skins, cinchona, oxen, sugar, cotton, and some copper ore. The city was the last stronghold of the Spanish (1823); it was blockaded by the German and British fleets in 1902–3, as the most valuable port of entry and the best place to collect their claims on Venezuela. Pop. (est.) 14,000.

Puerto La Mar, lä mär. See Cobija.

Puerto Plata, plä'tä, Santo Domingo, port of the Dominican Republic on the north side of the island of Haiti. The entrance to the harbor is extremely narrow; steamship lines connect with Europe, Saint Thomas and Havana, and it is connected by rail with Santiago de los Caballeros.

Industries.— Puerto Plata is the export town of the rich tobacco, sugar, and coffee plantations in the interior of the island, and the annual trade amounts to $1,500,000. There are several valuable coal mines nearby and there is also an extensive trade in mahogany.

Public Buildings, etc.— A white cheesebox fort, a relic of the buccaneers, situated upon a small promontory, is the only defense of the town. On one side is the new jail, on the other the barracks. There is the Commercial Club, for the older people, which has a library of 1,000 volumes, and the young men and young women have clubs, occupying commodious buildings. The houses are of modern wood and galvanized iron construction, neatly painted; the streets are straight, clean, macadamized and curbed; and the sidewalks are of stone flagging.

Schools.—The school system is modern and consists of two kindergartens, in charge of trained teachers, two boys' and two girls' primary schools, two normal schools and 15 private schools, assisted by the municipality, some of them teaching English and all planned to do so.

Government.— Municipal authority is vested in a mayor and common council, elected by the people, the mayor being president of the council. The city has a police department, a school board, and is the only city on the island having a street cleaning department; it is well lighted and has waterworks. The city debt is but $5,000; the annual budget is about $40,000, of which one third is spent for education.

History, Population, etc.— The town was settled in the first decade of the 16th century by Spaniards. About 30 per cent of the population speak English.

Puerto Principe, prēn'sē-pä, Cuba, (1) town, capital of the province of Puerto Principe: 170 miles northwest of the city of Santiago de Cuba. It was originally founded in 1515 at Nuevitas, the site of an old Indian village, on the northern coast, but was moved to its present site in 1516. For a time after 1800 it was the seat of government for the Spanish West Indies, and until the end of Spanish rule was an important military post. It is the largest inland city of the island, and is connected with its port, Nuevitas, by railroad. It is the centre of a cattle-raising district, and exports cattle, hides, etc.; sugar also is cultivated somewhat in the vicinity and exported. The town is very mediæval in appearance, the streets are narrow, and the houses old; during the American occupation artesian wells were bored to obtain a pure water supply, the streets were repaired, a good drainage system introduced, and buildings for schools remodeled.

(2) Province, east of the centre of the island, bounded on the east by Santiago de Cuba, and on the west by Santa Clara; area 11,000 square miles. The north of the province is mountainous, the most of the surface being high tableland affording excellent pasturage. The chief industry is cattle raising, which though it deteriorated during the war, is being rapidly revived, and the number of cattle largely increased; the finest horses on the island are also raised here. The province is also well wooded, and lumbering is an important industry; the minerals include iron, copper, and asphalt, all of which are mined to some extent, asphalt being of the most commercial importance. General agriculture is carried on mostly in the vicinity of the town of Puerto Principe, and its port, Nuevitas; sugar is the most important agricultural product. The province was a centre of the insurrectionary movement, and Cubitas in the northern part was the seat of the insurgent government in 1896–8. Puerto Prin-

cipe is the second province of Cuba in size but is least densely populated.

Puerto Real, rä-äl', Spain, a seaport in the province of Cadiz; on the Bay of Cadiz; seven miles east of the city of Cadiz. The greater part of the town is modern, on the site of Portus Gaditanus, an old Roman place. It has considerable manufacturing; the chief products are leather, pottery, linen goods, cements, vermicelli, and starch. It has a good harbor and an extensive trade; the chief exports are salt, fruit, and manufactures.

Puerto Rico, rē'kō. See PORTO RICO.

Puerto de Santa Maria, dā săn'tä mä-rē'ä (PORT SAINT MARY), Spain, city in Andalusia, in the province of Cadiz and seven miles northeast of the city of Cadiz; on the Guadalete, near its mouth in the Bay of Cadiz. It is on the railway from Seville to Cadiz. It has a town-house; theatre; a bull-ring, where was given the grand bull-fight to the Duke of Wellington, described by Lord Byron; five promenades, one of them planted with orange and other trees; infantry and cavalry barracks; a custom-house; a good edifice near the mole; a court-house; a parish church in the Gothic style; etc. Leather, soap, hats, wines, liqueurs, etc., are manufactured, and some fishing is carried on. This is one of the Spanish ports from which sherry is exported. Its vicinity to Cadiz, the centre of exchange, is favorable for trade. The principal articles of import are wood and iron. Steam-boats ply regularly between the Puerto and Cadiz. Pop. about 22,000.

Pufendorf, poo'fĕn-dŏrf, **Samuel**, BARON VON, German publicist and historian: b. Chemnitz, Saxony, 8 Jan. 1632; d. Berlin 26 Oct. 1694. He studied theology and law at Leipsic and in 1657, philosophy at Jena; was tutor in the house of the Swedish ambassador at Copenhagen, and by his work, 'Elementa Jurisprudentiæ Universalis' (1660) secured the appointment, the first in Germany, to the professorship of the law of nature and of nations at Heidelberg in 1661. Here he taught till 1670, and wrote 'De Statu Rei Publicæ Germanicæ,' published in 1667 under the pseudonym of Severinus Mozambano, and which, from the hardy way in which some of the imperfections of the Germanic constitution are exposed, raised a storm of controversy. Partly with a view to escape unpleasant consequences, Pufendorf accepted in 1670 the post of professor of natural law in the university at Lund, offered him by Charles XI. of Sweden. He there wrote his work on natural law, 'De Jure Naturæ et Gentium' (1672), which superseded the former; soon after appeared the abstract of this work, 'De Officio Hominis et Civis' (1673), which has passed through innumerable editions and been translated into several languages. Pufendorf in these works deviated still further than Grotius from the scholastic method of philosophizing, and consequently excited violent opposition. Some years afterward he was appointed secretary of state, royal counsellor, and historiographer at Stockholm. There he wrote in Latin the 'History of Sweden from the Campaign of Gustavus Adolphus in Germany to the Abdication of Queen Christina' (1676), and the 'History of Charles Gustavus' (1696), and in German his 'Einleitung zur Geschichte der vornehmsten Reiche und Staaten' (1682). These works so much increased his reputation that in 1686 he was called to Berlin as counsellor, historiographer, and judge of the supreme court of judicature. In 1690 he was made privy-councillor of the Elector of Brandenburg, and in 1694 was created baron by Charles XI., king of Sweden. Pufendorf's legal writings are regarded as marking an epoch in the history of natural law, treating it as based upon the social instinct and developing it as a philosophical morality, while allowing scope to revelation.

Puff-adder, one of the names of the American serpents of the genus *Heterodon* (see HOG-NOSE); also of the South African death-adder (q.v.).

Puff-balls. See FUNGI.

Puff-birds, a family (*Bucconidæ*) of tropical American picarian birds, resembling kingfishers in form, but living on insects like flycatchers. They are closely related to the barbets.

Puffer. See GLOBE-FISH.

Puffin, a kind of guillemot or auk (q.v.) common on all far northern sea-coasts, where they breed on remote cliffs in large companies. They compose the genera *Fratercula*, *Lunda*, etc., and are distinguished by the large and greatly compressed beak, which is deeply furrowed by three grooves on each side of the mandible. The colors of the beak also add to its singular appearance; this structure being colored bluish-gray at its base, orange-red in the middle, and bright red at the tip. Lastly a large portion of it is annually molted. The body is short, stout, and rounded. These birds excavate burrows in sandy ground, each depositing a single egg of white color. They are able to bite and scratch severely by means of their bills. Puffins swim and dive with great ease; their food consisting of the smaller fishes, and chiefly the young of the sprats and herrings. They are caught and their flesh is salted for food by the inhabitants of the Orkney and Shetland Islands. The appearance of the bill in these birds has gained for them the British provincial names «coulter-neb» and «sea-parrot.»

Pug. See DOG.

Pug Mill. See CLAY.

Pug'aree, or **Puggery**, a piece of muslin worn round a hat or helmet in hot climates or warm weather, the ends being left falling down, to protect the head by keeping off the rays of the sun.

Pugatscheff, poo'gä-chĕf, **Yemelyan Ivanovitch**, Russian revolutionist: b. Simoweisk, on the Don, Russia, about 1726; d. Moscow, Russia, 10 Jan. 1775. He was leader of a band of robbers in his early youth, served in the Seven Years' war in the Russian, Prussian, and Austrian armies successively, and on his return to Russia was implicated in a seditionary movement and imprisoned. He escaped and, prompted by his resemblance to the murdered Peter III., pretended to be the czar. The peasantry flocked to his standard, and were promised relief from their oppressions. His forces constantly increased and success for a time attended him. With 16,000 men in his army he captured Kazan, the old Russian capital, and moved upon Moscow, when he was betrayed by his followers to Suvaroff, captured, and taken in an iron cage to Moscow, where he was executed.

Puget, Pierre Paul, pē-ār pōl pü-zhā, French painter, sculptor and architect: b. Marseilles 31 Oct. 1622; d. there 1694. He began his career in art as apprentice to a ship-builder named Roman, who set him to carving the figure decorations for the prow and poop of galleys which the prevailing fashion demanded. At 17, however, he gave up this pursuit and traveled to Italy on foot, visiting Genoa, Florence and Rome, and in the latter place entered the school of Pietro da Cortona. This master's influence was always apparent in Puget's painting. In 1643 he returned to Marseilles and to ship-designing. Later he spent six years at Rome in company with a feuillant monk on a commission from Anne of Austria to make drawings of antique monuments. After 1653 he painted pictures for churches of Marseilles, Aix and Toulon; but finally abandoned painting on the advice of physicians. His first work as a sculptor, the caryatides supporting the balcony of the Hotel de Ville, Toulon, was a venture into realism, the figures being studied from the porters on the quays. These received the praise of Bernini. He produced two works similarly conceived, 'Hercules Overcoming the Hydra' (now in the Musée de Rouen), and 'La Terre' for the Chateau de Vaudreuil, Normandy. His other works are more in the manner of the Italians of the 17th century, an influence confirmed by another visit at the instance of Fouquet. The fall of that minister put an end to his commission, and Puget settled in Genoa, where he sculptured a 'St. Sebastian and St. Ambrose' for the Church of Santa Maria-in-Carignano and a 'Conception' for the Brignoli, now in the Albergo dei Poveri. His natural restlessness induced his return to France, where he became attached to the arsenal of Toulon as decorator of war vessels. But under the patronage of Colbert he resumed sculpture and executed the 'Milo of Crotona,' 'Alexander and Diogenes' (bas relief), and later the 'Perseus and Andromeda,' all three at present in the Louvre. The 'Alexander and Diogenes' has been called «the triumph of picturesque sculpture,» though, as Delacroix has pointed out, its subject is one impossible for sculptural treatment as the ray of sunlight which Alexander intercepts can not be represented. His architectural works are not numerous, though he erected the church of the Charité and the Capuchines at Marseilles. Consult: Lagrange, 'Pierre Puget, Peinteur, Sculpteur, Architecte' (1868); Émeric David, 'Histoire de la Sculpture française' (1872).

Puget (pū'jĕt) **Sound,** in the State of Washington, is a large, irregular inlet from the Pacific Ocean. The Sound proper begins at the junction of Juan de Fuca and Georgia straits, and extends south, dividing into two main branches, the eastern one called Admiralty Inlet, and the western Hood Canal. Some of the largest Sound inlets on the east shore are Elliot, Poverty, and Commencement bays; on the west shore, Dogfish Bay and Dye's Inlet, and on the south shore, Carrs, Budd, and Totten inlets. The area of this great landlocked body of water is about 2,000 square miles. It has a number of islands, Vashon and Bainbridge being the largest. A number of rivers, having their headwaters in the Cascade Mountains, flow into the Sound. the principal river inlets are Duwamish, Nisqually, Nooksak, Puyallup, Skagit, Skokomish, and Snohomish. The Sound has a number of large and safe harbors, and many miles of deep-water front. There is scarcely a sunken rock or reef in the whole body of water. The waters teem with fish; 95 varieties of food fish have been found. The shores are well-wooded, although there has been extensive lumbering in the surrounding forests. The fir is shipped to foreign ports for use in shipbuilding. The cleared lands in the vicinity make most productive farms. Seattle, Tacoma, and Port Townsend are the largest towns on the Sound; but all natural conditions exist for an extensive commerce.

Pughe, pū, **William Owen,** Welsh antiquary: b. Tyn y Bryn, Merionethshire, 1759; d. 1835. Going to London at 17 he there met the Welsh literary student Owen Jones, and the two published in 1795 the poems of Dafydd ap Gwilym, a 14th century bard. They subsequently edited other Welsh poems, and, assisted by Edward Williams, published the 'Myvyrian Archaiology of Wales' (1801–7). Pughe edited also 'The Welsh and English Dictionary' (1793–1803); the 'Cambrian Biography' (1803); etc. He accomplished not a little in arousing interest in Welsh language and literature.

Pu'gilism. See BOXING.

Pugin, pū'jĭn, **Augustus Charles,** English architect and draughtsman: b. Normandy 1762; d. London 19 Dec. 1832. He settled about 1798 in London, where for many years he was assistant to the architect Nash. He subsequently devoted his attention to mediæval architecture, and published 'Specimens of Gothic Architecture selected from various Ancient Edifices in England' (1821–3). With John Britton he published 'Architectural Illustrations of the Buildings of London' (1824). Later works were 'Specimens of the Architectural Antiquities of Normandy' (1825–8) with Le Keux; 'Gothic Ornaments selected from various Buildings in England and France.'

Pugin, Augustus Welby Northmore, English architect: b. London 1 March 1812; d. Ramsgate, Kent, 14 Sept. 1852. He early displayed skill and facility in architectural drawing and acted as assistant to the Grieves in painting scenery for Covent Garden and Her Majesty's Theatre. His taste for Gothic art was turned to account in designing the furniture for Windsor Castle, and in supplying Messrs. Rundell and Bridge with designs for mediæval plate. He became a convert in 1834 to Roman Catholicism, and devoted himself thenceforth to the illustration and revival of Gothic architecture in connection with the Roman Catholic Church. His treatise 'Gothic Furniture and Iron Work' appeared in 1835, and attracted attention. In the following year he published 'Contrasts, or a Parallel between the Noble Edifices of the 14th and 15th centuries and Similar Buildings of the Present Day,' in which he expressed in no measured terms his views as to the decadence of ecclesiastical architecture. Other works of Pugin were 'The True Principles of Pointed or Christian Architecture' (1841); 'An Apology for the Revival of Christian Architecture' (1843); 'The Glossary of Ecclesiastical Ornament' (1844). He was employed by Sir Charles Barry in the decoration of the houses of Parliament, and was connected with Hardman of Birmingham in the manufacture of the renowned Gothic brass-work, besides having a share in the manufactory of stained glass in the same town. Latterly his intellect gave way, from the incessant excitement and labor to which it was subjected, and he was removed to an asylum.

Puisne (pū'nĕ) **Judge,** in law, a former term for a younger or inferior judge.

Puket, poo-kĕt', or **Tonka,** a port of Lower Siam, the chief town of Junkseylon or Salang island, on the west coast of the Malay Peninsula. The town is on the east coast of the island at the entrance to a wide and deep bay. It is the seat of the commissioner of the west coast. Its importance is due to its valuable tin mines yielding an annual average of 3,000 tons. Pop. est. 20,000.

Pulangui, poo-län'gē, river of the Philippines, the upper part of the Grande de Mindanao. See MINDANAO, GRANDE DE.

Pulaski, pū-läs'kĭ, **Casimir,** COUNT, Polish soldier of the American Revolution: b. Lithuania 4 March 1748; d. Savannah, Ga., 11 Oct. 1779. He studied law, served in the army under Charles, duke of Courland, and in 1769 engaged with his father and brothers in the uprising against King Stanislas Augustus. He commanded the insurgents for a time after the death of his father and brothers and in 1771 made an unsuccessful attempt to capture the king at Warsaw which resulted in a sentence of outlawry being passed upon him. Further resistance was soon rendered useless by the coalition of Russia, Austria, and Prussia, and Pulaski made his escape to France where he met Franklin and offered his services to the cause of American independence. He obtained letters from Franklin to Washington and in 1777 joined the army of the latter as a volunteer. He performed distinguished service at the battle of Brandywine and received from Congress promotion to the rank of brigadier-general in command of a division of cavalry. He resigned his command after five months, joined the main army at Valley Forge and received permission from Congress to organize an independent corps of cavalry and light infantry which became known as Pulaski's Legion. In 1779 he marched with his men to join General Lincoln in South Carolina where he performed effectual service. In the siege of Savannah he commanded the French and American cavalry and in an assault on 9 October was mortally wounded and was carried on board the United States brig Wasp in Savannah harbor where he died two days later.

Pulaski, Fort. See FORT PULASKI.

Pulcheria, pŭl-kē'rĭ-a, Byzantine empress: b. 399; d. 453. She was the daughter of the Emperor Arcadius, upon whose death in 414 she became co-ruler with her brother Theodosius II., who was content to leave the reins of power in her hands. With her two younger sisters she took the vow of virginity, as she was determined that there should be no contests between three husbands for the empire. She condemned the Nestorian and Eutychian heresies and was on the friendliest terms with Cyril of Alexandria, Pope Leo the Great, and other great men of the time. She was a fine scholar, earnest in her devotion to the Church and active in promoting the welfare of her subjects. She arranged the marriage of her brother and after the marriage of his daughter with Valentinian III., she retired for a time from the court. On the death of Theodosius, however, in 450 she again assumed the throne, for state reasons was absolved from her vow of virginity and married the general Marcian whom she raised to the throne as her colleague. After her death she was canonized and her feast is still celebrated in the Greek Church.

Pulci, Luigi, loo'jē pool'chē, Italian poet: b. Florence 15 Aug. 1432; d. Oct. 1487. He came of a family in which poetical talents were hereditary; and had two brothers who were also poets, Bernardo, who wrote elegies on Cosmo de' Medici and translated Virgil's Eclogues, and Luca, who composed stanzas on the Tournament of Lorenzo de' Medici. Luigi far surpassed his elder brothers in talent, and became an intimate of the household of Lorenzo the Magnificent. At the instance of Lucrezia Tornabuoni, mother of Lorenzo, he composed an epic poem, 'Il Morgante Maggiore,' based on the tale of Roland, and recited it canto by canto at the table where such men as Poliziano, Ficino, Michelangelo Buonarotti, and Cristofero Landino gathered. This fact accounts for the diversity of its contents both in respect to the subject matter and the spirit in which it is handled. He assumed the tone of Florentine society at the time of its composition, and inserted at will or to suit the changeable temper of his audiences passages of moving pathos or sincere devotion amid others of coarse buffoonery and broad humor. He fell in with the general Italian tendency of treating the Carlovingian legend with less seriousness than did Northern peoples, but he infused a specially bourgeois spirit by his use of many words of the Tuscan dialect. It has been asserted that Shakespeare's familiarity with Pulci is evidenced in his creation of Iago and Othello. Byron was a confessed admirer, and translated the first canto of 'Morgante Maggiore' which he published with 'Beppo' and the 'Vision of Judgment.' See PUNCHINELLO.

Pulcinello, pŭl-chĭ-nĕl'ō. See PUNCHINELLO.

Pulilan, poo-lē'län, Philippines, pueblo, province of Bulacán, Luzon; on the Quiñgua, five miles above its junction with the Grande de Pampanga; eight miles northwest of Bulacán, the former provincial capital. Pop. 10,100.

Pulitzer, pū'lĭt-sėr, **Joseph,** American journalist: b. Budapest, Hungary, 10 April 1847. He came to the United States in 1864 and joined a Federal cavalry regiment, serving till the end of the Civil War; then became a reporter on the 'Westliche Post,' which Carl Schurz had made the leading German newspaper in Saint Louis. Beginning upon the lowest round of a journalist's career, and at first enduring considerable hardship, he rapidly won recognition and rose to the position of managing editor and chief proprietor of the paper. In the meantime he had acquired a knowledge of law, had been admitted to practice and been active in politics in the Republican ranks. He was elected to the Missouri legislature in 1869, was a delegate to the convention of the Liberal Republican party at Cincinnati, which nominated Horace Greeley for president, then became a Democrat and in 1874 was a member of the Missouri State constitutional convention. In 1876–7 he was Washington correspondent for the New York *Sun*, and in 1878 bought the Saint Louis *Dispatch* and united it with the *Evening Post* as the *Post-Dispatch*. In 1883 he purchased the New York *World*, soon building up a large circulation. He was elected to Congress in New York in 1885–7 but resigned after a few months. In 1887 his health was broken, due to overwork, and was followed by a steady loss of eyesight until he became totally blind. Mr. Pulitzer as an editor was marked throughout by great ability and genius. In August, 1903, announcement was made of the endowment of a College of Journalism by him at Columbia University. He also endowed several scholarships at Columbia College and gave largely to other educational and charitable causes. He died at Charleston, S. C., 29 Oct. 1911.

Pulkova (pool'kō-vä) **Observatory,** in Russia, founded by the Czar Nicholas, and built in 1835–9, is at the village of Pulkova; lat. 59° 46′ 18″ N., and lon. 30° 19′ 40″ E. It was intended for the study of sidereal astronomy. The chief instrument, the refractor, with a 15 inch aperture, was not equaled by any other like instrument in the world, until 1870 when the Newhall Observatory (q.v.), in Newcastle, England, secured a 24 inch refractor. Next came the 26-inch refractor for the Naval Observatory (q.v.) in Washington, D. C. In 1885 the Pulkova Observatory erected a 30 inch refractor made by Clark & Sons of Cambridgeport, Mass. This instrument is (1904) excelled by the 36-inch Lick glass, and the Yerkes telescope at the University of Chicago. The determinations of fundamental star places, as made at the Russian Observatory, are regarded as most accurate, and its investigations cover a wide field. The Observatory is not only doing remarkable original research; but it is also a training school for astronomers and geodesists. Doctor Otto Struve has been the director from the beginning. The Repsolds of Hamburg mounted the Russian telescope.

Consult: ‘Description de l'Observatoire Astronomique central de Poulkova’; ‘Zum 50-jährigen Bestehen der Nicolai-Hauptsternwarte’; ‘Publications de l'Observatoire central Nicolas.’

Pul'lan, Richard Popplewell, English architect and archæologist: b. Knaresborough, Yorkshire, 27 March 1825; d. Brighton, Sussex, 30 April 1888. He was educated at Christ's Hospital, studied church architecture and in 1851 was engaged with Wyatt in charge of the decoration of the Byzantine and Gothic halls in the Crystal Palace. In 1854 he visited Sebastopol where he made a model of the country and fortifications, which he exhibited on his return home. He was commissioned in 1857 by the architectural department of the foreign office to examine the Halicarnassus mausoleum and also to make excavations at Cnidus; in 1862 he was engaged in excavating the temple of Bacchus at Teos and that of Apollo Smintheus in the Troad; and in 1869 was engaged in a similar task at the temple of Athene Polias at Priene. He wrote: ‘History of the Discoveries at Halicarnassus’ (1862–3); ‘Byzantine Architecture’ (1864); ‘Lectures on Christian Architecture’ (1879); ‘Principal Ruins of Asia Minor’ (1865); ‘Eastern Cities and Italian Towers’ (1879); etc.

Pullè, Giulio, joo-lē'ō poo-lā, Count («Riccardo Castelvecchio»), Italian dramatist: b. Verona, Italy, 1820. He attained much popularity as a dramatist and among the most successful of his numerous works are ‘Romilda’; ‘Il Duca ed il Forzato’ (1856); ‘La Donna romantica’ (1858); ‘L'Ecole des Femmes’; ‘La Donna pallida’ (1888); etc.

Pullè, Leopoldo, Count («Leo di Castelnuovo»), Italian dramatist, son of Giulio Pullè (q.v.): b. Verona, Italy, 17 April 1847. He is prominent politically, has held various important municipal offices, is connected with the leading dramatic societies, and as a dramatist has won considerable attention. His publications include: ‘Il guanto della Regina’; ‘Bere o affogare’; ‘Pesce d'aprile’; ‘Scene e fiabe’ (1889); ‘Discorsi parlamentari di Marco Minghetti’ (1890); etc.

Pul'len, Henry William, English Anglican clergyman and author: b. 29 Feb. 1836; d. 26 Dec. 1903. He was educated at Marlborough and Cambridge, took orders in the English Church, became a minor canon of York in 1862, and was minor canon of Salisbury 1863–75. He became chaplain of the Alert during its Arctic expedition of 1875–6, and for his services on that voyage was awarded the Arctic medal. He attained a sudden fame by the publication in 1870 of the brilliant ‘Fight at Dame Europa's School,’ of which 193,000 copies were sold and 14 translations made. He also wrote: ‘Modern Christianity a Civilized Heathenism’ (1872), the circulation of which reached 20,000 copies; ‘The Ground Ash, a Public School Story’ (1873); ‘The Council of Canterbury’ (1882); ‘The House That Baby Built’ (1874); ‘Pueris Reventia’ (1893); ‘Venus and Cupid’ (1896); ‘Fred and Fritz’ (1898). He edited Murray's ‘Handbooks to Italy, Rome, and Greece’ (1886–96).

Pulley, a mechanical appliance by which a force applied at one point is transmitted to and acts at another with a change in its direction or intensity, or in both. By its application the power exerted may raise a weight much larger than itself, or impart to the weight a velocity much greater than its own; but, as in the case of all mechanical devices, the energy is merely transformed; never created.

In its simplest form it consists of a wheel of wood or metal which turns on a smooth axle attached to a surrounding frame, usually in the form of a block. The rim of the wheel is grooved so as to allow a rope, cord, or chain to pass around it. Its principle of action is that of reduplication, depending on the fact, first enunciated by Stevin, about 1610, that the tension of a rope is the same at every point

Under this principle a fixed peg would serve the purposes defined just as well as a wheel, which is introduced for the specific purpose of reducing the amount of friction.

In the single «fixed» pulley, Fig. 1, to satisfy the condition of equilibrium, the tension of the rope must be the same on both sides of the wheel, therefore, the power applied is equal to

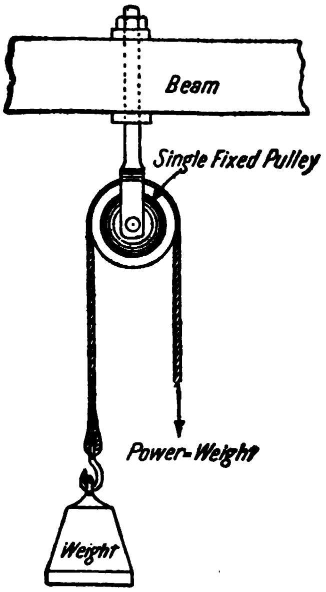


Fig. 1.

the weight, and although no mechanical advantage is gained by its use, it serves to change the direction of the force applied, and to obtain a pull on the beam to which it is attached, equal to twice the amount of that force.

In the single movable or "free" pulley with parallel strings, Fig. 2, as in the fixed pulley, the tension of the rope on both sides of the wheel is the same; but, since the weight is supported by two upward forces each of which is equal to the force applied, the power is equal to one half the weight, or in other words, the power that will lift a given weight by the use of a single fixed pulley will lift twice that weight by the employment of a free pulley.

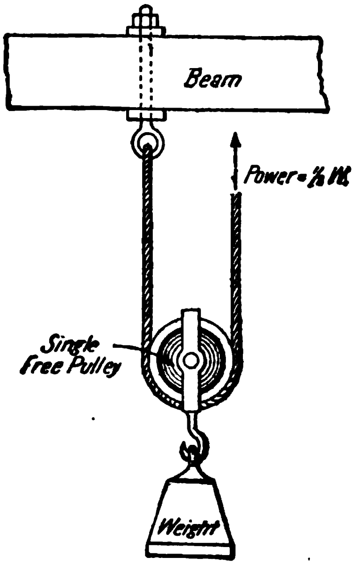


Fig. 2.

Fixed and free pulleys may be combined in various ways to obtain a mechanical advantage. In the combination shown in Fig. 3, the tension on the beam at (a) is equal to the power applied, and at (b) it is equal to twice that power; but the relation of the power to the weight remains the same as in the case of the single free pulley.

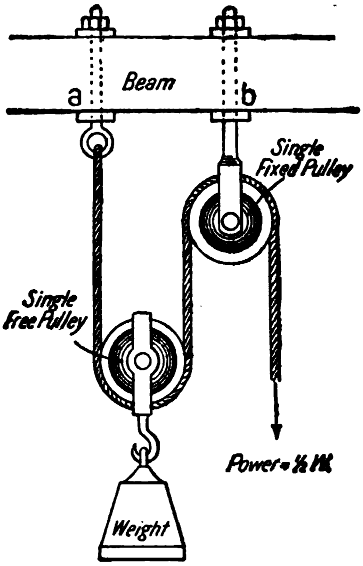


Fig. 3.

If, however, the supporting strings pull at an angle (2ϕ), Fig. 4, the pulley is acted upon by three forces—the weight (w) acting vertically downward, and two equal forces ($p \cos. \phi$) acting upward. The resulting effect, $2p \cos. \phi = w$, shows a mechanical disadvantage,

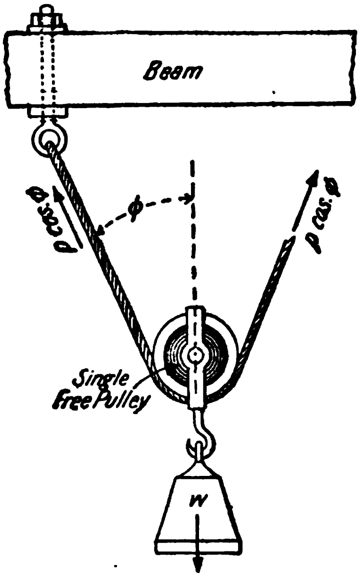


Fig. 4.

since the power required increases with the angle, and $p = \frac{1}{2}w$, as shown by Figs. 2 and 3, only when $\phi = 0°$, that is, when the strings are parallel. When $\phi = 60°$, the power is equal to

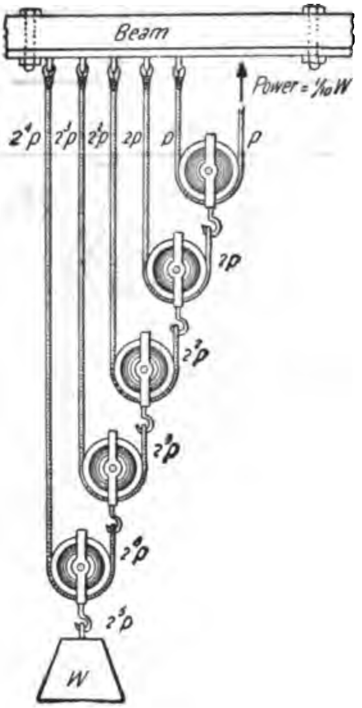
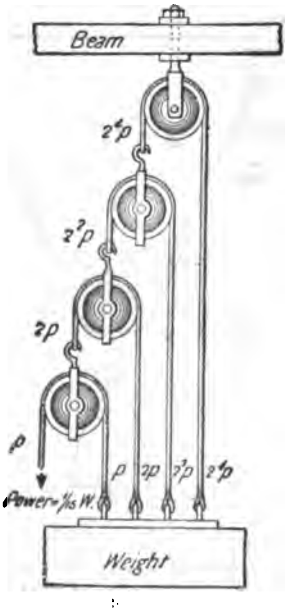


FIG. 5.

the weight; and when $\phi = 90°$, or $2\phi = 180°$, an infinite amount of power would be required to draw the rope out horizontal.

Combinations of pulleys or compound pulleys are usually arranged according to one of the three systems represented by Figs. 5, 6, and 7, which indicate the action of the supporting forces.



In the first system, Fig. 5, five independent pulleys are supported by an equal number of branches from the main chord. The mechanical advantage stated in terms of weight (w) and power (p) is $w = 2^5p$, or in general $w = 2^np$, when (n) represents the number of pulleys.

In the second system, Fig. 6, the weight is supported by the four forces, $p + 2p + 2^2p + 2^4p = 15p = (2^4 - 1)p$, or in general, $w = (2^np, - 1)p$.

In the third system, Fig. 7, one continuous string is divided into six branches by six pulleys, and since the tension of each branch is equal to (p) the power applied, $w = 6p$, represents the mechanical advantage, or $w = np$, when (n) is the number of strings rising from the movable pulley. This is the form most frequently used practically, its most extensive application being the block and tackle devices of the running rigging of ships. See BLOCK; TACKLE.

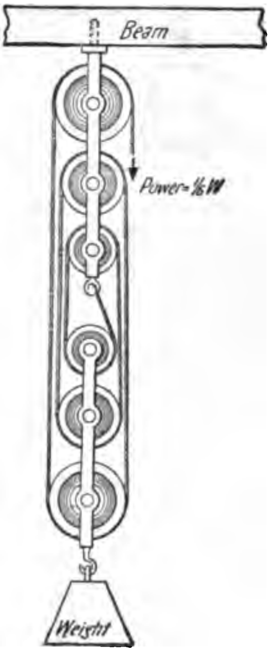


FIG. 7.

For other examples of the application of pulleys, see TRANSMISSION OF POWER — *Mechanical*.

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Pull'man, George Mortimer, American inventor: b. Chautauqua County, N. Y., 3 March 1831; d. Chicago, Ill., 19 Oct. 1897. He learned the cabinetmaker's trade, and during the construction of the Erie Canal he successfully filled contracts for removing various large buildings in its proposed route. He then settled in Chicago and engaged in building, but devoted much time to the problem of making long railway journeys less tedious, the result being the conversion of two ordinary railway coaches into sleeping cars. They were a success and created a demand for more, and in 1863 he built the "Pioneer" at a cost of $18,000, which was the first of the cars which have since borne his name. He organized in 1867 the Pullman Palace Car Company, of which he was president, and in 1887 originated the vestibule train. He amassed an immense fortune, founded a model town near Chicago, which he named Pullman (q.v.), and was interested in various other large commercial enterprises.

Pullman, James Minton, American Universalist clergyman, brother of G. M. Pullman (q.v.): b. Portland, N. Y., 21 Aug. 1836; d. Lynn, Mass., 22 Nov. 1903. He was graduated from Saint Lawrence University, Canton, N. Y., in 1860, ordained to the ministry in 1862, held pastorates in Troy, N. Y. (1860–7), New York (1867–85), and Lynn, Mass. (1885–1903). He organized the Young Men's Universalist Association of the City of New York in 1869, of which he was the first president. He was also president of the New York State Universalist Association.

Pullman, Ill., a former town, now part of the city of Chicago; on Lake Calumet, 12 miles south of the centre of Chicago. It was founded in 1880 by George M. Pullman, and intended especially for the benefit of the employees of his company. Besides the Pullman Palace Car Company, which is located here, there are car wheel works, a foundry, and other industrial establishments. It was formerly under the government of the Pullman Company, but in 1889 the town voted for incorporation with the city of Chicago.

Pulmona'ta, an order of non-marine gasteropod mollusks, characterized by breathing atmospheric air; the snails. They are usually small, asymmetrical, and provided with a shell. The sexes are always united in the same individual, and the operculum is always wanting, except in *Amphibola*. The respiratory apparatus, which seems to have been modified from that of ancestors who breathed oxygen mixed with water, by means of branchiæ, is not lung-like in structure; it is simply a pouch lined with blood-vessels, and is properly called a pulmonary sac.

Pulmotor, The. The Pulmotor is a new machine, which produces artificial respiration. It was first used in Europe in connection with mine rescue apparatus. Later it was used by the U. S. Bureau of Mines in similar work. They found it so satisfactory in resuscitating after all kinds of suffocation, such as asphyxiation from gas, electric shock, and cases of apparently drowned, that large gas and electrical companies have installed them; also many hospitals, city fire and police departments.

Formerly in cases of asphyxiation, morphine poisoning, drowning, or electric shocks, efforts to restore respiration consisted in laying the patient on his back and alternately pulling his arms over his head and forcing them down upon his chest, thereby causing an expansion of the lung cavity, and then compressing it, thus first producing artificial breathing. In such cases it became necessary to force the patient's mouth open and pull out his tongue, thereby affording free passage for the air, which alternately was drawn into the lung cavity and immediately expelled. This process is superseded by the application of the Pulmotor, which operates as follows: An iron cylinder 3½ x 21 inches contains the oxygen at a pressure of about 2,250 pounds when completely filled and will operate the Pulmotor 40 minutes continuously. This life-sustaining gas also furnishes the energy which is required to induce breathing, in the following manner: The oxygen from the tank flows through a reducing valve, which at the outlet side maintains a pressure of about 75 pounds, and from there to the controlling valve. Initially, the passage to the lungs is open through this controlling valve. The latter connects two flexible braided copper tubes leading to a metallic face cap with a rubber rim, which closely fits the patient's face. The patient's tongue is drawn down over the lower jaw and under the mask, by means of a set of tongue forceps which is provided. The oxygen then has free access to the lungs.

When the pressure in the lungs has reached a certain value, 20 centimeters, a bellows interconnected with the lung cavity through the flexible braided copper actuates the controlling valve. The pressure of oxygen is now directed so as to create a suction over the connections which lead to the lungs, thereby causing exhalation of the gases previously forced into the lungs. When a vacuum of 25 centimeters is reached in the lungs and bellows, the outer atmosphere acts on the latter, which in turn operates the controlling valve and again admits the oxygen to the lungs. The frequency of these reversals depends upon the size of the lung cavity, a larger space requiring greater time, while with smaller lung cavities the operation is correspondingly more frequent. This process is continued until the patient shows signs of natural respiration. The Pulmotor action is then discontinued and the patient is allowed to breathe the pure oxygen through another small face cap connected by a hose directly to the oxygen tank. The Pulmotor is patented in all foreign countries and the United States by Bernard Draeger of the firm Draegerwerk, Luebeck, Germany. The American agents are The Draeger Oxygen Apparatus Co., Pittsburg, Pa. The inventor is Mr. Bernard Draeger, and instructions for its operation were drawn up by Dr. Roth of Luebeck, Germany.

Pulo Malagi, poo-lō'mä-lä'hē, an island of the Philippines. See MALAGI.

Pulp. See PAPER.

Pulque, pul'kĕ. This Mexican national beverage is produced from several species of agaves known as majuays (*A. salmiana, potatorum, Americana*, etc.), which are extensively cultivated on the plains of Apam, in a radius of 50 to 100 miles from the Mexican capital. So extensive is the industry that the plantations of Hidalgo, Tlaxcala, and Puebla, are valued at nearly $15,000,000.

Pulse (from Latin, *pulsus*, a beating), the rhythmical motion of an artery, with alternate expansion and contraction, in practice considered as a beating. This motion is strongest in the heart (q.v.), which is the centre of the arterial system, and from that organ it is propagated through all the minutest branches of the arteries. In those which lie immediately under the skin it can be felt with the finger, as is the case with the radial artery, the pulsation of which is very perceptible at the wrist. The state of the pulse is therefore an indication of the action of the heart and the whole arterial system, and of the condition of the blood and the physical functions in general. The circumstances to be attended to in the pulse are either the number of pulsations which take place in a given time, and the regularity or irregularity of their occurrence, or the character of each pulsation. In the former case the pulse is said to be quick or slow according to the number of pulsations in a given interval; regular or irregular, as they occur at equal or unequal intervals. In the latter case it is strong or weak, hard or soft, full or small, etc. It is affected by the age, sex, and temperament of the individual, and by accidental circumstances, as sleep, food, exercise, heat, etc.

The pulse is most rapid in infancy, making from 110 to 140 beats per minute. During early childhood it makes from 100 to 110, and is regular, and rather soft and small. In youth it is much slower, making from 80 to 90 beats per minute. At this period it is regular, strong, rather soft than hard, moderately full. In mature age the number of beats is on the average about 75 per minute, and the pulse is regular, strong, or moderate, fluctuating between hard and soft, between full and small. In old age the number of beats sinks to about 60. In the female the pulse is more rapid, softer, and smaller than in the male. In persons of a sanguine temperament it is quicker and fuller than in phlegmatic individuals. Sudden agitation and violent passions make the pulse rapid and irregular; joy makes it quick and strong; long-continued grief, languid and soft. The pulse is, therefore, a highly important indication of the state of the system. A deviation from the regular pulse of an individual indicates a disordered state. When the irritability of the system is so heightened as to produce fever or inflammation the pulse is accelerated. If the action of the nervous system is irregular, or unduly heightened, the pulse becomes frequent and irregular. In case of mechanical obstructions to the circulation, as in dropsy of the pericardium, polypus in the heart or in the great arteries, the pulse is irregular and interrupted.

The study of the pulse began with the ancients. Galen wrote several works on it, and for several centuries the subject of pulsation remained much as he left it. The demonstrations of the circulation of the blood by Harvey, and of the irritability of the muscular fibre by Haller threw new light on it, and medical science at last has brought it under full investigation, and has explained it in all its physiological aspects.

Pulse Glass, an instrument invented by Franklin to exhibit the ebullition of liquids at low temperatures. The bulbs are connected by a slender stem and partially charged with water, the supernatant air having been expelled by boiling, and the opening hermetically sealed by a blow-pipe. By grasping one of the bulbs the heat of the hand will cause the formation of vapor and drive the liquid into the other bulb, producing a violent ebullition in the latter.

Pulsom'eter. See PUMPS AND PUMPING MACHINERY.

Pulszky, pul'skē, **Franz Aurelius,** Hungarian archæologist and publicist: b. Eperies 1814; d. Budapest 1897. When only 22 he was nominated to membership in the Archæological Institute of Rome. Joining the Liberal party under Kossuth he was elected a deputy to the Hungarian Diet in 1840 and later under-secretary to the Hungarian Prince Esterhazy, minister of foreign affairs in Vienna. He followed Kossuth to England and after the catastrophe of Villagos accompanied the ex-dictator to America. His impressions of this country were embodied in a book entitled 'White, Red, and Black.' Condemned to death by his country for treason, he lived in Italy and joined cause with the Garibaldians. The sentence was removed in 1866; in 1872 he became inspector-general of museums and public libraries. He wrote 'Philosophy of Hungarian History' (1882); 'My Life and Times'; and 'The Jacobins in Hungary' (1887).

Pulteney, pult'nĭ, **William,** EARL OF BATH, English politician: b. London 22 March 1684; d. there 7 July 1764. He was educated at Oxford, and in 1705 entered parliament. He was a partisan of Walpole, and after the accession of George I. was made privy councillor and secretary of war, 1714–17. In 1725 he became a political opponent of Walpole, gained great popularity by his crusade against his former friend, and when Walpole was forced from the ministry in 1742 Pulteney organized under the Earl of Wilmington a new ministry. The public was disappointed in the cabinet, and his acceptance of a peerage further destroyed his popularity. As member of the House of Lords he was not prominent, and when appointed premier in 1746 he held office but two days, being unable to form a cabinet.

Pultowa, pool'tō-vä, or **Poltava,** Russia, (1) capital of the government of Poltava; on the Vorskla River; about 450 miles southwest of Moscow. It is walled and defended by a citadel on a small eminence. It is the commercial centre of a large farm and stock-raising region. The annual fairs, three in number, are of less importance than in former years. Here in 1709 Peter the Great defeated the Swedes under Charles XII. A monument in the principal square commemorates the event; and three miles from the town is the tomb of those who fell in this battle; it is still called the Swedish Tomb. Pop. about 55,000. (2) A government in the southwestern part of Russia in Europe, bounded on the north by Tchernigor, on the east by Kharkov, on the south by Ekaterinoslav, and on the west by Kiev; area, 19,265 square miles. The surface is a plain sloping from the northeast to the southwest, and drained chiefly by the Dnieper and its tributaries. It is one of the most fertile and best cultivated departments of Russia; it exports about one fourth of the whole produce of wheat, oats, and barley of the whole country. Tobacco is increasing in acreage. Stockraising and bee-keeping are given much attention. Manufacturing is limited; the chief products are leather, coarse woolen goods, brandy, and saltpeter. Oil is made from the seed of the sunflower and of flax. Pop. about 3,000,000.

Pultusk, pool'toosk, Russian Poland, town in the government of Lomza, on the Narev, about 32 miles north by east of Warsaw. It has several old buildings of historic interest, some manufactories, and considerable trade. It is noted as the scene of the defeat of the Saxons by Charles XII., in 1703, and of the Russians by the French in 1806. Population estimated, 16,000.

Pulvermacher Chain, in electricity, a form of galvanic battery consisting of a series of small wooden cylinders on which a zinc and copper wire are coiled side by side, but without touching each other. The zinc of one cylinder, touching the copper of the adjacent one, forms with it a couple. The whole is immersed in vinegar diluted with water. A chain of 120 couples forms a very powerful battery. See Battery.

Pu'ma, or **Mountain Lion.** See Cougar.

Pum'ice, a variety of lava of a porous and fibrous structure, resembling that of a sponge in appearance, containing from 60 to 75 per cent of silica, with alumina, iron, lime, soda, etc. It varies in color from whitish-gray to yellowish-brown and will float in water. It is essentially lava from which steam or gas has escaped in large quantities while it was being consolidated. Its extreme roughness fits it for use in polishing. In the solid state it is used to polish paint, wood, metal, etc.; and, as a powder, for marble, ivory, bone, glass, and in the composition of tooth-powder. Pumice may be considered because of its glassy composition as a porous variety of obsidian (q.v.). Pumice is obtained in Mexico, Iceland, and Hungary, but chiefly from the Lipari Islands.

Pumpel'ly, Raphael, American geologist: b. Owego, N. Y., 8 Sept. 1837. He was educated at the Owego Academy, and later studied sciences and mining engineering in Paris and at Freiberg, Saxony. He made geological investigations in Corsica, and after his return to the United States in 1860 visited Arizona, and in 1861–3 was engaged in scientific explorations under the government of Japan. In 1863–4 he made a private investigation tour through central, western, and northern China and Mongolia, and in 1864 engaged under the Chinese government in examining the northern coal fields. In 1866–73 he was professor of mining at Harvard, State geologist for Michigan in 1869–71, and in 1871–3 directed the State geological survey of Missouri. He was appointed to the United States geological survey in 1879–81, 1884–91, in charge of the Archæan division, and was organizer and director of the Northern Transcontinental Survey in 1881–4. The development of the iron ore industry in Michigan and western Ontario was largely due to his investigations in 1867–1901, and his time is now occupied in organizing and directing an exploration expedition to central Asia. He has published: 'Geological Researches in China, Mongolia, and Japan' (1866); 'Iron Ores and Coal Fields of Missouri' (1873); 'Geology of the Green Mountains' (1894); etc.

Pum'pernickel, the name given to a coarse brown bread made in Germany from unbolted rye. It is baked in large, square loaves, which often weigh as much as 60 pounds. Its proper manufacture depends upon the treatment of the dough, which must contain neither yeast nor leaven, and also on the management of the oven, in which the batch must remain from 12 to 14 hours.

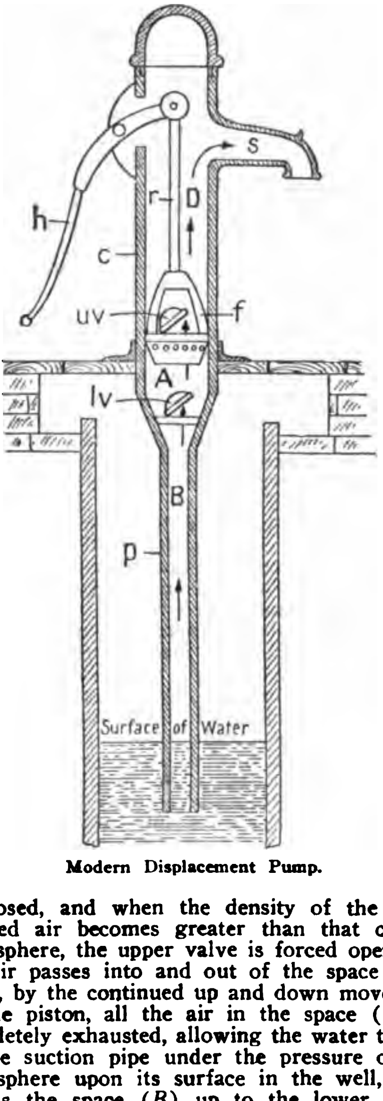
Pump'kin, any of several annual vine-like herbs, especially *Cucurbita pepo,* of the order *Cucurbitaceæ,* probably of tropical America, but not known in a wild state. It is a coarse tendril-bearing vine frequently exceeding 20 feet in length, with prickly stems and leaf stalks; bears large rough leaves; large yellow flowers, the pistillate being followed by large variously colored but generally yellow fruits, with hard rinds, thick flesh and many seeds. The plant is widely cultivated in warm and temperate countries for its fruits, which range in weight from 10 to 40 pounds, but in some varieties weigh far more. They are largely used for stock feeding and for making pies. The cultivation is essentially the same as for squashes; but in America the plants are most frequently grown in corn fields, the seeds being sown at intervals of about 12 feet, and the plants allowed to shift for themselves after the corn is laid by. It is affected by the same insect-enemies as the squash (q.v.).

Pumps and Pumping Machinery. The term «pump,» commonly used to designate the various forms of mechanical devices by which liquids and gases are moved, is of very doubtful origin. It might have been derived from the French «pompe,» or the German «pumpe,» «plumpfe,» or the Latin «plumbum,»— lead, the last-named although advanced by some authorities, appears to be the result of a rather far-fetched conclusion. In its broadest application it designates a multifarious variety of appliances and machines, some simple and others of complicated mechanical construction, which may be grouped into four general classes — «bucket-lifts,» «displacement-pumps,» «impellers» and «impulse» pumps, according to their mode of action, and disregarding their motive power.

«Bucket-lifts,» for raising water from wells or other sources to receiving points above that of the supply, by means of a counterbalanced pole or sweep (swape), and by a windlass or wheel, operated by hand, or with the aid of draught animals, represent the earliest forms of pumps. They were used during the remotest periods, and are commonly used even at the present time, their application not being confined so much to particular localities as to their cheapness and the limited supply of water required. The most primitive device of this character was probably the «cistern-pole.» Pliny, 52 A.D., mentions it in his description of the various methods employed in watering gardens. He states: «Water is drawn from wells and tanks by plain poles, hooks and buckets.» The «swape» was a natural evolution from the cistern-pole, and in the form of the «shadoof,» of Egypt, is authentically recorded as having been in use over 1,500 years B.C., in the time of the Pharaohs, a period antedating the Exodus. It is still used extensively in that region, myriads of them lining the banks of the Nile, where they are worked unceasingly by relays of men, without intermission, day and night. It is also used extensively all over Hindustan, where it is called the «picotah.» In fact, the «swape» in some form is used extensively in all of the Oriental countries from Asia Minor to China and Japan and also in Mexico and South America, for domestic purposes and for the irrigation of land. For the latter purpose, however, it was superseded in India by the «jantu,» an oscillating wooden trough involving the same principle, that of the lever, and worked by hand. The «windlass and bucket» arrangements operated by cranks or by tread-wheels, the latter worked by men or animals, appear to have followed the «swape,» first among the Chinese, and later among the earliest Greeks and Romans. Tread wheels appear to have been a common mode of applying human and animal effort among the ancients, and are often used even at the present time, although not so much in connection with pumping water. About the beginning of the Christian Era, Vitruvius, a Roman engineer, described a number of pumping machines involving a rotary principle — the «tympanum,» «noria,» «chain of buckets or pots,» the «screw» and the «pump.» The tympanum consisted of a series of gutters with their open ends joined to a shaft hollow at one end and placed above the surface of the water at the height to which the water was to be elevated. The gutters thus arranged radially extended to a short distance below the surface of the water which they scooped up successively when the shaft was rotated. Each gutter as it passed above the horizontal position, delivered its water to the shaft to be subsequently discharged through a trough at the desired point. This primitive device continued in use from the remote ages of antiquity up to the 18th century without any change of construction, when La Faye, a member of the Royal Academy of Sciences of France, improved it by substituting a series of curved canals for the original straight gutters, thus developing the progenitor of the «scoop wheel,» which propelled by streams, are extensively used for draining purposes. La Faye's improvement and the geometrical reasoning which developed it are exhaustively described by Belidor (Tom. ii. 385, 387). While the tympanum consisted of a series of revolving gutters, the noria may be described as a number of «swapes» arranged around a central shaft like the spokes of a wheel, each swape carrying on its outer end a vessel which fills as the rotary motion of the shaft plunges it beneath the surface of the water, and subsequently discharges its liquid freight into a reservoir placed at the upper part of the circle. It is commonly known as the Persian wheel. The «chain of buckets or pots» was an elaboration of the simple bucket and cord arrangement, by the introduction of a pulley operating an endless rope or chain, to which several buckets or pots were attached. It was employed by all the foremost nations of antiquity, and is still used in many parts of Europe and Asia. Among half-civilized nations it was the highest type of hydraulic machines. Sometimes, when the source of supply was a river, as in the case of the Persian wheels on the Orontes, the driving wheels of the arrangement were placed in the river and propelled by its current. About the middle of the 17th century, European mechanics recognized that when the water was admitted into the receiving vessels of a noria or a chain of pots at the upper part of the circumference, it was converted into an over-shot wheel, thus affording a means of power transmission to other machines, and in cases where the water supply was limited, but descended from a considerable elevation, it was substituted for the overshot wheel as a prime mover in operating mining pumps, dredging, threshing and other machines of a similar character; while as a conveyor, originally used exclusively as a water elevator, it has also been employed to raise mortar in the construction of buildings, city walls and fortifications, and for carrying grain and flour to the different floors of a mill. In its original form, that of the «sakia» of Egypt, it was unquestionably the pump introduced into Greece by Danaus when he dug the wells of Argos, 1485 B.C., about a thousand years before the building of Babylon by the Persians. Danaus was a brother of the Pharaoh Rameses, who reigned during the period the Israelites were in Egypt. He was compelled to leave that country on account of domestic troubles, and accompanied by his family and friends sailed for Greece. They landed on the coast of Meloponessus, and settled at Argos. According to Pliny (vii. 56), previous to the arrival of these Egyptians, the Greek were unacquainted with wells and pumps; therefore, it is natural to conclude that the wells of Argos dug by Danaus were equipped with the Egyptian pumping devices most adaptable to wells, which was the chain of pots, and not a form of atmospheric or force pump, the pioneer of which is described in Hero's 'Spiritalia' as invented by Ctesibius of Alexandria, one of the most eminent mathematicians and mechanicians of that period, in the year 224 B.C. The most modern refinement of the chain of pots is the «chain pump,» while Vera's «rope pump» and the hydraulic belt are applications of the same idea, and consist of endless double bands of rope or woolen cloth passing over two rollers, one placed below the surface of the water, the other at the point of delivery. The rollers are driven at a velocity ranging from one to two thousand feet per minute, and as the bands pass over the upper roller, the water held between them by capillarity is forced out by the pressure and discharged into a receiving chamber connected with the delivery spout.

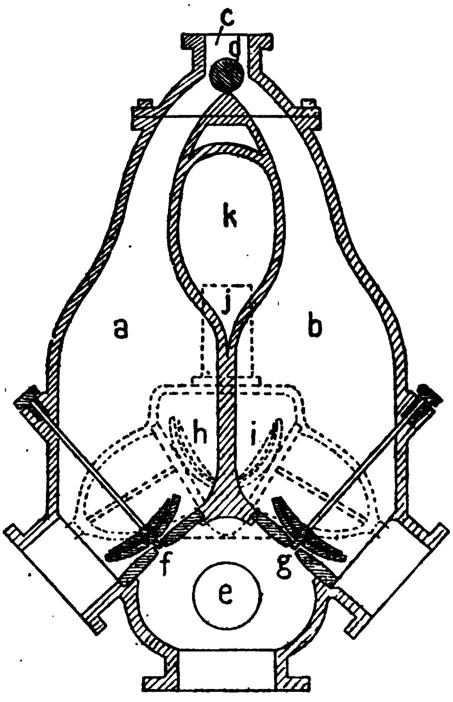
Machines embodying the principle of the screw, stated by some authorities as invented by Archimedes, the Greek geometrician and greatest mathematician of antiquity, and by others credited to the genius of Canon of Samos, a contemporary of Archimedes, about the year 242 B.C., are described by Vitruvius as of Egyptian origin, and were, according to other authentic records, employed in Egypt, for draining and irrigating land, many centuries before Archimedes visited that country. It consists of one or more flexible tubes of lead or leather, wound spirally around a solid cylinder of wood or iron, the ends of which are pivoted to supports, so that the whole arrangement may be revolved upon its axis, which is generally placed at an angle of 45° to the horizontal. The lower end of the tube is placed below the surface of the water, and the upper end over a receiving trough at the desired elevation. When the machine is rotated the water entering the lowest bend of the spiral is forced upward by each succeeding revolution into the other bends, and finally discharged out of the uppermost into the trough. The Roman screws were made with plank grooves arranged spirally around a solid cylinder, and the grooved cylinder thus constructed was fitted into and revolved within a hollow cylinder of the same length.

The connecting link between the various more or less elementary forms of water elevators or «lifts» already described, and the group of hydraulic machines designated as «displacement pumps,» is the modern chain pump, consisting of a tube through which the water is raised by a series of pallets or pistons. The pump of Ctesibius appears to have been of this character, although it consisted of only two single-acting pistons working in a cylinder, the water being raised by the up-stroke and expelled by the down-stroke, into a common receiving chamber. In this machine the atmospheric pressure was not taken into consideration, and its capabilities as a water-lifter remained unrecognized until 1643, when Torricelli, the great Italian physicist, announced that water could be raised in a tube by the pressure of air. In 1641, Gallileo, when consulted by a Florentine pump-maker, had failed to demonstrate why water failed to rise in a closed tube above a height of 33 feet under the action of a suction pump. A year or two later, after the death of Gallileo, Torricelli undertook the explanation of that fact, his experiments finally resulting in establishing the law that the heights attained by liquids in a closed tube, the upper end of which was a vacuum, under the pressure of the atmosphere, was proportional to their specific gravities. For example, under these conditions, the height of a column of mercury would be about 28 inches, while that of a column of water would be about 33 feet at the level of the sea. The direct result of this experiment was the invention of the siphon barometer, in which the empty space above the column of mercury is known as the Torricellian vacuum; but, through the further experiments of Pascal, a French mathematician and divine, in 1646, followed by those of Otto Guericke, a philosopher and mathematician of Magdeburg, Prussia, and of Candido del Buono, a member of the Academie del Cimento of Florence, it led to the invention of the «air pump,» an apparatus which is described under the title air pump, and which must not be confounded with the atmospheric or displacement pump used for pumping water, which was not unknown to the ancients, and was probably used in some of its innumerable forms, long before the days of Ctesibius. In its simplest form, the modern atmospheric or displacement pump consists of a cylinder (*c*) connected at the bottom with a pipe (*p*), the lower end of which is immersed below the surface of the water. In the cylinder are placed two valves (*uv* and *lv*), the lower stationary and the upper attached to a piston (*f*) at the end of a rod (*r*), which moves the piston up and down under the motion of a handle (*h*). A pipe or spout (*s*), attached to the cylinder near its upper end, receives and discharges the water raised by the working of the piston. Both the valves open upward, and the action of the entire arrangement, based upon the physical fact that two bodies cannot occupy the same space at the same time, is as follows: When the downward stroke of the handle moves the piston upward, the air in the space *A* being rarefied by having to occupy a greater space, and the partial vacuum thus formed relieves the pressure of the atmosphere from the lower valve, which being opened upward by the pressure of the air in the space (*B*) of the pipe, allows a portion of it to pass into the space (*A*). When the piston descends under the upward stroke of the handle, the air in the space (*A*) is compressed, the lower valve is closed, and when the density of the compressed air becomes greater than that of the atmosphere, the upper valve is forced open and the air passes into and out of the space (*D*). Thus, by the continued up and down movement of the piston, all the air in the space (*B*) is completely exhausted, allowing the water to rise in the suction pipe under the pressure of the atmosphere upon its surface in the well, until it fills the space (*B*) up to the lower valve. The next upward movement of the piston empties the air in the space (*A*), which is immediately filled with water by the opening of the lower valve. The downward motion of the piston closes the lower valve and forces the water through the upper valve into the space (*D*), from which it is discharged through the spout by the next upward movement of the piston which at the same time refills the space (*A*). Under the laws of fluid pressure established by the experiments of Torricelli and others, the height to which a column of water will rise depends upon the atmospheric pressure at any point on the earth's surface, and varies with the altitude of that point. At the level of the sea,



Modern Displacement Pump.

the atmosphere exerts a pressure of about 15 pounds to the square inch, and will support a column of water in a closed tube from which the air has been exhausted, between 32 and 33 feet in height, while upon the top of Mont Blanc, or Pike's Peak, 15,000 or 16,000 feet above the sea, the atmospheric pressure will support a similar column of water about 16 or 17 feet in height. A knowledge of this fact is important not only in determining the maximum distance at which the lower valve of a pump may be placed from the surface of the water, but also in every branch of hydraulic engineering. There are numerous forms of displacement pumps. Usually they are equipped with a piston which fits the cylinder tightly and operates as already described. Some forms employ a plunger which but partly fills the cylinder, and instead of driving all the water out of it, merely displaces a volume equal to that of the plunger itself. In others, the displacement is effected by jets of air or steam. In all of them, valves form an essential part. In the simplest forms the valves are made of leather or rubber, and are fixed in position by a hinge on the edge. They are made in a great variety of forms and operate by pressure, or, as in the case of the Reidler valve, a German invention, by mechanical means. They usually consist of a “valve seat,” to which the “disk” or valve proper is attached, the “stem” which controls the lift of the disk and prevents its displacement from the seat, the “cover plate,” and the “valve spring,” introduced in some forms to take up slacks. When a valve is required only to prevent the back pressure or a reverse flow, a single flap or check valve is used. In large pumps a number of small valves are employed, equal in the aggregate to a single large valve of sufficient size to allow the passage of the whole flow, thus preventing injurious shocks when the valves are opened and closed suddenly. Excepting the disks, all the other parts of a valve are made of bronze, while metallic ball and cone valves are extensively used in deep well pumps. The sub-classes into which displacement pumps may be grouped are almost innumerable, but the most important are the “reciprocating” pumps in which the pistons or plungers move alternately back and forth, or up and down, in a straight line, and are designated single-acting when the water is displaced by one part of the stroke, and double-acting when it is displaced by both parts of the stroke of the piston. In a single-acting pump, the water is forced into the ascending pipe only by the downward part of the stroke, and is discharged intermittently, while in the double-acting form, the discharge is continuous, thus saving the power wasted by the ever-recurring acceleration and retardation of the ascending column of water. Of the many methods employed to produce this very desirable result, the most common is that in which an air chamber is fixed vertically on the discharge pipe and receives the water forced upward by the downward stroke of the piston. The air in the chamber being compressed acts as a spring, and returns the force gradually to the ascending column of water as the piston moves upward, thus equalizing the pressure so as to give a uniform discharge. “Direct-acting” displacement pumps are so designated when the motive power is applied in a direct line with the movement of the piston or plunger, and differentiates them from the “crank-and-fly-wheel,” and the “beam pumps,” when such devices are employed to transmit the motion. The additional designations — simple, duplex, triple, etc., are applied to pumps according to the number of pistons — one, two, three, or more, operated by a unit of motive power. “Rotary pumps” are equipped with revolving pistons, the axes of which are parallel, and the longitudinal surfaces formed into a series of curves which interlock on the inside and revolve with a tight sliding contact on the outside, against the curved walls of the pump chamber. Screw pumps and chain piston pumps are merely the modern refinement of very old ideas, while the “pulsometer,” although one of the latest of modern pumping devices, may be regarded as the connecting link between ordinary pumps and what may be correctly termed “pumping-engines” — machines in which the pump and motive power are combined, the displacement being effected by steam. It consists of two bottle-shaped chambers (*a*) and (*b*), the tapering necks of which incline toward each other in a common passage at (*c*). At the lower end of this passage is a valve (*d*), which when moved slightly will simultaneously close the opening of the neck of one chamber, and open that of the other.



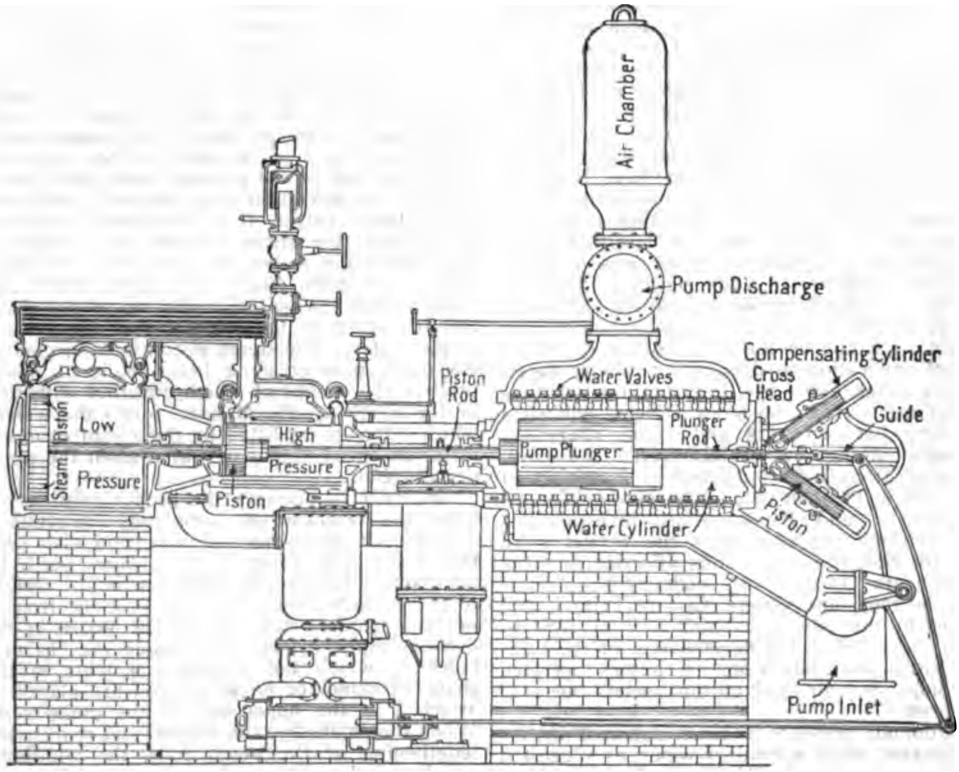
Pulsometer.

Water is admitted into the chambers through the passage (*e*), and valves (*f*) (*g*) and forced out through the valves (*h*) (*i*), and passage (*j*) into the air chamber (*k*). The device operates as follows: Suppose both chambers are full of water and the valve (*d*) to the right. When steam is admitted to the chamber (*a*) the water is forced out by direct pressure through the valve (*h*) into the air chamber (*k*), so that when the chamber (*a*) is nearly or quite empty, the valve (*d*) moves to the left, cutting off the steam from the chamber (*a*) and admitting it to the chamber (*b*), from which the water is gradually forced out. In the meantime, the condensation of the steam in the chamber (*a*) creates a partial vacuum, and the pressure of the atmosphere on the external water forces it through the valve (*f*) into the chamber, so that when it is nearly full, the air it contains will be sufficiently compressed to force the valve (*d*) over to the right, thus producing a continuous action. The efficiency of pulsometers is equal to that of small direct-acting feed pumps, but they are extensively used on account of their simple construction and great durability.

The expansive energy of compressed air, hot air, and steam, was probably employed by the ancients, as the motive power of pressure engines to raise water, many centuries before the Christian era. There are extant numerous authentic descriptions of devices equipped with piston bellows, employed for this purpose by the ancient Egyptians, Hindus, Chinese, Peruvians and the Aztecs. Also descriptions of hot air devices, and pressure machines operated by steam, the majority of which were contrived by the members of the ancient priesthoods. A great many of these machines are described in the 'Spiritalia' written by Heron, or Hero of Alexandria, a celebrated Egyptian mathematician and physicist, who lived in the 1st century A.D. The water jet apparatus known as Hero's Fountain, although asserted to have been invented by him, was probably an old device at the time he described it. In either case, it is the oldest pressure engine ever described accurately in which a volume of air was used instead of a piston. In 1560, Baptista Porta, an Italian, published a work entitled 'Natural Magic,' in which he described a method of producing a vacuum by the condensation of steam, and its application to devices for raising water. Similar descriptions are given in the writings of Jerome Cardan, also an Italian, published sometime between 1515 and 1570. Therefore, although nothing new was discovered by Decaus, whose writings were published in Frankfort in 1615, and in Paris in 1624, or by Fludd, Worcester, Savery, and Papin, whose investigations and writings extended over the period from 1663 to 1698, the suggestions afforded by their experiments (subsequently elaborated by Freiburg in 1797, and Shone, Callon, Frizzel, and Pohle, in the period extending from 1870 to 1900), have led to the development of the various forms of modern air-lift pumps operated by compressed air, and pulsomemeters operated by steam.

Although pressure engines operated by air compressed under a head of water, as suggested by Papin in 1695, had been employed successfully to drain mines as early as 1755, when Hoel employed one in the mines of Chemnitz, Hungary, the application of steam for that purpose did not become an accomplished fact until a much later period. It is, however, interesting to note that the idea was suggested by Lord Bacon prior to 1679, in connection with the English mines, and was probably practically applied to a limited extent about that time. The history of the modern pumping engine, however, more properly begins with the construction of the Cornish engine. Up to the close of the 18th century, the only practical use of steam engines was in connection with pumping devices, and many notable steam pumping engines had been erected and successfully operated in the mines of Cornwall, England. The various improvements made in this engine from 1800 to 1840 finally culminated in the evolution of one superior type which is now known as the "Cornish." This engine gave highly satisfactory service for the particular purpose for which it was designed — the raising of water out of deep mines where the constantly increasing depth of the shafts necessitated the adaptation of the same engine to the consequent increasing and changing loads. It is constructed upon the principle that the steam within the steam cylinder, is used to lift a weighted pump plunger which after being raised upward to the limit of its stroke, descends slowly by its own weight and forces upward a column of water equal to that weight. The economy produced by the expansion of the steam in the steam cylinder when the steam is cut off during the descent of the plunger is due to the fact, that the pressure and power of the steam first admitted is greatly in excess of what is necessary to lift the weighted plunger. This excess of power is taken up by the weights of the plunger at the beginning of its stroke, and given out at the end when the power of the exhausted steam in the cylinder has fallen below the amount necessary to move the plunger, unless assisted by the power previously stored in it. The length of the stroke of the piston and of the plunger being determined solely by the operation of its steam, equilibrium, and exhaust valves, it is absolutely necessary to maintain the steam pressure at a uniform rate, while the water raised must be received under a uniform head. In mine pumps, the steam cylinder is placed at the top of the shaft, and the pump at the bottom, near the surface of the water. The steam piston is connected to the pump plunger by a beam made of heavy timbers, the weight of which, together with that of the weight of the plunger, forms the weight which, after being lifted by the steam cylinder, raises an equal weight of water when the plunger descends.

In order to preserve the proper relation between the weight of the pump rods and plunger, and that of the water columns, and also keep the engine and pump at the proper speed, by maintaining the proper difference in the weight of the pump rods so as to overcome the friction of their guides, and that of the water in the delivery pipes, a large box, called the "balance bob," in which the adjusting weights in the shape of stones or pieces of iron are placed, is attached to the upper end of the pump rods. When the shafts become deeper, and require the lengthening of the pump rods, the additional weight of the new timbers is counterbalanced by a readjustment of the weights in the "balance bob," thus adapting the engine to the new conditions. In its particular field of application, requiring only a slow action with no demand for uniform flow, it is safe to state that it has never been excelled by any other engine; but, its inordinate size, its action which requires the constant watchfulness of the engineer, its great first cost and expensive repairs, makes it unfit for waterworks, where the water has to be discharged through a long main to a great height above the pump, with a continuous and uniform delivery. The shortcomings of the Cornish engine, named above, led finally to its complete abandonment for waterworks, and called for a pumping engine that would fulfill the new requirements. This demand was met by the development of the «rotative» engine which, by employing revolving instead of reciprocating pistons, gave a positive motion. The steam power in the cylinder is applied to the pump piston in various ways — through the medium of long or short beams, bell cranks, or gearing, and in some instances, directly through the pistons themselves; in all cases, however, the limit of the stroke of the steam piston and of the pump plunger being governed by a crank on a revolving shaft. Attached to this shaft is a fly-wheel which is designed to assist the crank to pass the centre at each end of its stroke, and also to give up at the beginning of each stroke of the steam piston the excess of power imparted to it beyond that required to move the column of water. The function of the fly-wheel of a rotative engine is exactly similar to that of the weighted plunger in a Cornish engine; both of the devices being applied to their respective classes of engines to obtain the best economy in the consumption of steam, the early cut-off resulting in a high grade of expansion, much higher than it was possible to obtain by any other means at the time. They vary greatly in design and in the details of construction, and are made in sizes ranging from those used for supplying water to small towns, up to some of the largest and most expensive machines in the world, and operate either vertically or horizontally. They produce great economy in the use of steam at the expense of intricate machinery, but require expensive and massive foundations to absorb the shocks produced by their operation, while the momentum of the fly-wheel greatly increases the percentage of possible accidents. The Leavitt engines represent the vertical, and the Holly-Gaskill, the horizontal type.



Worthington High Duty Pumping Engine.

To follow further the progress of pumping-engine construction up to the invention and development of the «direct-acting steam pumps,» which now represent the highest type of pumping machinery, it is necessary to take up the historical thread in the United States. Although steam pumping engines of the direct-acting type, beginning with the device invented by Thomas Newcomen and John Cawley, of Dartmouth, England (which was subsequently improved by Watt, who developed it into an engine of the double-acting type), were in great use for many years; the greatest improvement in this class of pumping engines was made by Henry R. Worthington of New York, in 1840. His invention was the outcome of a long series of experiments on the application of steam to the propulsion of canal boats. It was a single direct-acting steam pump, and was employed to feed the boilers of his propelling engine, and was patented for the first time in 1841. A «direct-acting» steam pump is one in which the power of the steam in the steam cylinder is transferred to the piston or plunger in the pump by means of a continuous connection. It has no revolving parts such as cranks, shafts, and fly-wheels, like those of the rotative engines, nor the balanced beams and weighted plungers of the Cornish. Its action is due to the operation of a piston by a uniform pressure of steam through the entire piston stroke against a uniform water pressure in the pump, the pump piston-speed being governed by the difference between the power exerted in the steam cylinders over the resistance of the water in the pumps, while the length of the steam-piston stroke is limited and controlled by the admission, suppression and release of the steam used in the cylinders. Although steam pumps of this type came immediately into extensive use for feeding boilers, and for supplying moderate quantities of water under medium pressure, the intermittent action of their pump pistons, and consequent irregular flow of water prevented them from being used in waterworks and for other purposes where large quantities of water had to be forced through long lines of pipes. To overcome this serious defect, the same inventor produced the improved pump which is now generally known as the «Worthington direct-acting duplex steam pump.» It consists of two direct-acting pumps placed side by side with the piston-rod of each pump connected by a lever to the slide valve of the opposite steam cylinder, so that the movement of each piston instead of operating its own slide valve, as in the single-acting pump, operates the slide valve of the opposite cylinder. The resulting valve motion is such that just before the piston of one pump has finished its stroke, the piston of the other begins its movement. The load of the water column is then taken up alternately and produces a steady flow without serious strains, harshness of motion, and noise, which characterize the action of the single-acting pumps, in which the water column is started into motion at the beginning, and arrested at the end of each stroke of the piston. Although the simplicity of their mechanism, together with the cheapness of their first cost and the certainty of their action, placed them at the head of all the machines of their class, when considered from a mechanical standpoint, the loss of economy in the use of steam continued to militate against their general use for large waterworks purposes. Their light weight prevented the cutting off of the steam in the steam cylinder so as to complete the stroke of the pump piston by the aid of the expansive energy of the steam thus cut off. Therefore the steam applied to move the pistons had to be applied in sufficient quantity and pressure to overcome the weight of the water column and its friction through the pump and connections, at the very beginning of the stroke, and maintained without diminution throughout the stroke, up to its termination, since a falling off in either volume or pressure during any part of the stroke would have stopped the action of the pump instantly. This defect, however, was completely eliminated by applying to them the principle of multiple expansion in the use of steam in compound condensing steam engines. Another steam cylinder was added to the end of the one already in use, and placed in a direct line with it so that the high pressure steam admitted to the first and smaller cylinder after moving its piston was exhausted behind the piston of the large cylinder upon its return stroke. Still further economy was produced in the larger compound engines by using a condenser to create a vacuum in the large steam cylinder, thus bringing the efficiency fully up to that of the best high-duty rotative engines of the most important pumping plants of the world, their yearly records ranging from 50,000,000 to 120,000,000 duty.

The duty of the Worthington pumping engines was still further increased, and the entire arrangement, from the power-producing to the pumping ends, was made to represent the highest perfection of modern pumping machinery, by the application of the accumulator attachment, a device originally invented by J. D. Davis, in 1879, and perfected by C. C. Worthington, in 1884, and designed to cut off the steam in the steam cylinder at the beginning of the piston stroke, where it subsequently expands and acts as an auxiliary force at the end of the stroke, while at the same time the force exerted by the steam upon the pump plunger remains uniform through the entire stroke. In a compound direct-acting steam pump, it is attached to the plunger-rod which projects through the outer end of the pump chamber. On the end of this rod is fastened a cross-head which moves in guides attached to the outer end of the pump. On this cross-head, and situated opposite to each other, are two semicircular recesses. On the guide plates are two journal boxes, one above and the other below the plunger-rod, equidistant from it, and placed at a point equal to the half stroke of the cross-head. Each journal box carries a short cylinder hung on trunnions, which allow the cylinder to swing backward and forward in unison with the motion of the plunger rod. In these cylinders are plungers or rams, which pass through a stuffing box on the end. The outer ends of the rams have rounded projections which fit into the semicircular recesses on the cross-head, which, as it moves in or out, carries with it the plunger, thus tilting the cylinders backward and forward. These cylinders are called «compensating cylinders.» When the engines are used for pumping water, they are filled with water, and when used for pumping oil, they are filled with oil. The pressure on their rams is produced by connecting the cylinders through their hollow trunnions with an accumulator, carrying a ram which moves up and down as the rams of the cylinder move in and out. This accumulator is of the differential type, the small lower cylinder of which is filled with water or oil, in which the ram moves, while the larger upper cylinder is filled with air. On the top of the accumulator-ram is a large piston-head which fits closely in the air cylinder. Therefore, the pressure per square inch on the accumulator-ram is equal to the pressure of the air in the air cylinder per square inch multiplied by the difference between the area of the air piston and that of the accumulator-ram. It is a matter of calculation and construction, which varies according to the particular service for which a pumping engine is designed; while the pressure in the air cylinder is controlled by the pressure in the main delivery pipe with which the air chamber is connected. The effect of this attachment on the successful operation of high duty pumping engines may be briefly described as follows: At the beginning of the outward stroke of the pump plunger-rod, the compensating cylinders point toward the outer end of the pump, with their rams at an acute angle with the plunger-rod, and pushing against its advance under the full pressure of the accumulator load. As the plunger-rod advances outward, the angle between itself and the ram is increased. The rams recede into their cylinders, and their pressure against the rod is decreased until the pump plunger-rod has reached the halfway point of its stroke, when the rams will be at right angles to it — a position in which they neither retard nor advance its movement. As the pump plunger rod continues on its outward stroke, the angle between itself and the rams is again decreased, but now the rams pointing in the opposite direction, emerge from their cylinders, and exert their power to push the plunger outward to the termination of its outward stroke. It is obvious that similar conditions obtain during the return stroke of the plunger, the effect of the action being to store up power at the beginning of the stroke, either forwards or backwards, of the pump plunger, when the steam is under its greatest pressure, and to relieve it at the end of the stroke, when the pressure in the steam cylinder has fallen away to its lowest point, that is, below the amount necessary to move the plunger against the pressure of the water column.

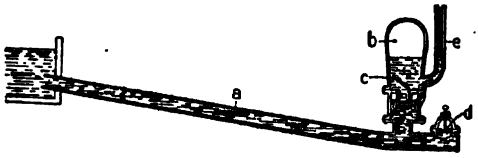
The Worthington pumps are all of the horizontal type, and with this attachment and the use of multiple expansion steam engines, operate with absolute freedom from the noise and shock so characteristic of the crank and fly-wheel machines. Somewhat of an idea of the difference between the first duplex Worthington pumping engines and those of their latest construction may be obtained by comparing that of the Charlestown, Mass., waterworks, with its capacity of 5,000,000 gallons per day, with the installation at the Baltimore, Md., waterworks high service pumping station, which delivers 18,000,000 gallons per day. The former gave a duty of 70,000,000 foot-pounds, while the duty of the latter exceeded 140,000,000 foot-pounds per thousand pounds of dry steam.

The term «duty» represents the work done by a steam pumping engine expressed in millions of pounds of water lifted to the height of one foot by the consumption of 100 pounds of coal, 1,000 pounds of dry steam, or by 1,000,000 British thermal units (B. T. U.). On account of the variable quality of coal, the two last named constants give the more correct results, and are the values now employed in determining the comparative efficiencies of pumping engines, which range from 20.6 per cent for the high-duty engines, to about 0.13 per cent for jet pumps. During the last one hundred years, the development of pumping engines has increased their duty from about 5,000,000 foot-pounds for the Newcomen atmospheric engines, to over 170,000,000 foot-pounds for the crank and fly-wheel, or duplex triple expansion pumping engines of the latest construction.

The «centrifugal pump» is the best known representative of the «impeller» type. It embodies the principle — that a body revolving around a centre tends to move away from it with a force proportional to its velocity: thus the rim of a revolving wheel imparts a portion of its velocity to any substance adhering to it, and throws it off when the force of the velocity thus imparted exceeds the force of adhesion, as the mud thrown off by the wheels of a carriage, or the water from a mop or towel, rapidly revolved by the hand. The first pump of this type was invented by M. Le Demour, who sent a description of it to the Academie Francaise in 1732. It consisted of a straight tube attached in an inclined position to a vertical axis, around which it was whirled by a crank-handle. Later forms were constructed by tubes joined in the form of a T, the vertical tube of which was placed in the water. The lower end perforated to admit the water, and fitted with a valve to retain the water in the vertical tube when the pump was not in operation, was placed under the surface of the water and supported upon a pivot. The ends of the horizontal discharge tube were bent down into a circular trough over which they were revolved. When the machine was revolved rapidly the centrifugal force which discharged the water in the horizontal tube was communicated to the water in the vertical, which was also drawn out, but in the meantime refilled by the atmospheric pressure. When it is required to lift large quantities of water to a low elevation, centrifugal pumps may be used with greater efficiency than reciprocating pumps, the efficiency of which diminishes with the lift. A pump of this kind constructed in Massachusetts in 1818, was equipped with four blades set at right angles like those of a fan blower, and was used practically for many years. An improved form was exhibited by Appold in England, in 1851, which embodied all of the principal features employed in the best pumps constructed since that time. It is stated that Appold's pump raised continuously a quantity of water equal to 1,400 times its own capacity per minute. The «whirlpool chamber,» designed to utilize the energy developed by the whirling water which in most pumps of this type is lost as eddies in the discharge pipe, was suggested by Thomson (Eng.), and consisted of a chamber somewhat larger than the pump, in which the water discharged by the pump disk, with considerable velocity, was allowed to rotate and impart its energy as an auxiliary aid to the driving power. A pump constructed by him for drainage purposes, in the Barbados, was equipped with a whirlpool chamber 32 feet in diameter, around a pump disk 16 feet in diameter. Others of large size were constructed by Easton and Anderson, for the North Sea Canal, in Holland, which were capable of delivering 670 tons of water per minute to a height of 5 feet; while the Gwynne pumps employed to drain the Ferrarese marshes in Italy, at the junction of the Po di Volano and the minor rivers of lower Lombardy, are capable of a combined delivery of 2,000 tons of water per minute.

A large variety of «rotary pumps,» although not involving the principle of centrifugal action, but highly efficient as «low lift» pumps, are represented by the turbine pumps, and the screw pumps. One of the last named type was constructed at Milwaukee to flush the sewage-polluted waters of the Milwaukee River, in 1889. It has a screw wheel 13 feet in diameter, which, revolving at a rate of 60 revolutions per minute, delivers 550,000,000 gallons of water a day on a lift of 4 feet. This water is forced through a brick-lined tunnel 12 feet in diameter, and 2,500 feet long.

«Impulse pumps» operated by the impact of air compressed by a falling column of water or other means, or by the force of a moving column of water suddenly arrested, are represented by numerous machines, of which the Shone ejector pump, employed to lift sewage, is the best example of the first, and the hydraulic ram, of the second. In the ejector, the compressed air rushes in from the air compressor at the central station and displaces the sewage in the receiving chamber, the falling sewage automatically shutting off the air supply when the chamber is empty.



Hydraulic Ram.

The hydraulic ram, first designed by Whitehurst, a watchmaker of Derby, England, in 1772, and subsequently perfected by Montgolfier, the famous French balloonist, in 1796, consists of a supply pipe (*a*); an air-chamber (*b*) attached to the upper side of the pipe (*a*), and fitted with a valve (*c*) at the pipe opening; a valve (*d*) at the end of the supply pipe, and a vertical pipe (*e*), connected to the air-chamber, through which the water is raised to the desired elevation. The device operates as follows: The valve (*d*) is made just heavy enough to descend and open the lower end of the pipe (*a*) when the water filling the pipe is at rest. Now assume that this valve is open, allowing the water in (*a*) to run out. This water gradually acquires additional momentum, which finally carries the valve up against its seat and closes the outlet. The water in (*a*) is thus brought to a state of rest and a part of it enters the air-chamber (*b*) through the valve (*c*). But, the instant the water in (*a*) is brought to a state of rest, the valve (*d*) descends, opens the outlet, allows the water to run out, and is again closed by the increasing pressure, bringing the water to rest and forcing some more of it into the air-chamber, thence through the pipe (*e*) to the point of delivery. The action of the valve (*c*) prevents the return of the water from the air-chamber to the pipe (*a*). This device is of simple construction, may be adapted to numerous locations in every country, and will operate automatically and continuously, without any attention whatever, so long as the surface of the water at the source of supply is kept at the same elevation, so as to insure a uniform pressure against the valve (*d*). When the perpendicular distance from the source of supply to the valve (*d*) is small, and the water is required to be raised to a comparatively great height, pipe (*a*) must be made of sufficient length to prevent the water from being forced back into the source of supply when the valve (*d*) closes. It is also necessary to maintain the supply of air in the air-chamber, which in time, under the great pressure, becomes depleted by being incorporated with the water. In small rams a sufficient amount of air enters through the valve (*d*), but in rams of considerable size a small «snifting valve,» attached to another chamber immediately below the air-chamber, automatically supplies the additional air whenever it is necessary.

Bibliography.—For further information consult: Barr, ‹Hydraulic Machinery› (New York 1897); Ewbank, ‹Hydraulic and Other Machines› (New York 1876); Hood, ‹Water-Supply and Irrigation Papers› (United States Geological Survey, No. 14, Washington, D. C., 1898); Turneaure, ‹Water Supply›; The ‹Scientific American Supplements› and the various engineering magazines and periodicals. Also see articles under AIR PUMP; AIR COMPRESSORS; FIRE ENGINES; STEAM ENGINES; TURBINE; TUNNEL; WATER MOTORS; WATER WHEELS; WATERWORKS.

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Pumps, Compressed Air. During recent years much progress has been made in the art of pumping water by compressed air. At first all systems of lifting water or liquids by means of compressed air were deemed extravagant, but the development of various systems has been such that water may be pumped with marked economy and rapidity by compressed air.

Plunger Pump.—The direct-acting piston plunger pump, of simple or duplex type, is operated with little economy in steam consumption. It is one of the most uneconomical devices known. One hundred and fifty pounds of steam per horse-power per hour is about a fair figure to take for this machine. Experiments have shown that under average conditions hardly 50 per cent of the indicated horse-power of the driving cylinder is utilized in the pump cylinder, the rest being absorbed partly by the engine as machine friction and particularly by the friction of the water in passage through valves and chambers.

The plunger pump consists essentially of two parts, an air end and a water end. The working fluid, which must either be steam or compressed air, operates a piston which transmits its energy through the piston rod which, in turn, causes the pump plunger to reciprocate and thereby pump water. A simple and efficient method for pumping by air in the plunger system is known as the «return pipe» or «closed circuit» system. In this the same air is used over and over again, the exhaust from the pumps being piped back to the compressor under a limited back pressure. In this case the compressed air is a transmitter of power just as a belt or transmission rope, but the air never wears out, may be carried to any distance and at any angle, has little inherent friction, and possesses the highest efficiency in transmission. The system eliminates all trouble from freezing since the air is used repeatedly and moisture once removed cannot be returned. While it requires two pipe lines instead of one, the pipe cost is frequently less because of the smaller pipe size permitted. The pump cylinders will be smaller because of the higher mean effective pressure, and the losses in clearance, often enormous, are entirely eliminated. The great economy in this system is secured in compression, since the scheme is based upon the well-known fact that the greatest losses in compression are thermodynamic, which losses are exaggerated at the lower pressures. For example, 13.42 horse-power will compress 100 cubic feet of free air to 60 pounds pressure, starting at atmospheric. This same energy will compress 100 cubic feet of free air to 350 pounds, when beginning compression at 60 pounds, giving on the return pipe system 290 pounds available pressure with 60 pounds back pressure. A reheater on the pump will secure additional economy. Losses through leakage and transmission are supplied by a small «booster» compressor.

Another method of securing high economy is to employ compound or triple pumps, reheating the air after each expansion. This may reduce the air consumption to ½ or ⅓ its value in the simple pump of the same capacity. In some cases this same result may be secured by the use of three pumps in series, reheaters being used as before after each expansion and the exhaust from one pump being supplied to the next, with a larger air cylinder.

Displacement Pumps.— The displacement pump is almost the essence of pumping simplicity and, if its first promises were borne out, it would be a most powerful factor in pumping problems. As it is, within its recognized field, it has shown a fitness which qualifies it especially for the work. In brief, it consists of two barrels or cylinders which are filled and discharged alternately — the charge in each cylinder being directly discharged or displaced by the admission of the required volume of compressed air through a valve automatically controlled.

The fundamental requirement is a complete submergence of three to six feet. The cylinders are filled at no expense of power and discharged with a minimum of friction losses. Dirt, sand, or grit will not interfere with its operation. Such a pump starts and stops automatically and uses air exactly in proportion to the amount of water discharged. It will run for weeks without attention and requires practically no repairs. Standard sizes have capacities up to 1,500 gallons per minute.

The height to which these pumps will lift water is limited only by the air pressure used, and by an arrangement of several pumps in series almost any height may be attained with ordinary moderate air pressures. In mine work the displacement pump is especially useful in handling accumulated water in sumps, dips, entries, etc. It is also peculiarly effective in subways and tunnels, in automatically discharging the seepage or leakage water which accumulates. It may also serve in the basement of factories and warehouses which are subject to occasional inundations by floods or high water. The same apparatus, but in slightly modified form, is employed for elevating acids and heavy chemical solutions or for pumping marl, paints and other semi-fluids. In this case the air valve is so located that it is not affected by contact with the liquid or by the corrosive fumes arising therefrom. The capacity of the displacement pump is determined by the size of the cylinders or chambers and the volume of air available. Employing air at ordinary pressure from a common single stage air compressor with a lift not exceeding 250 feet, the efficiency of the displacement pump is higher than that of the usual direct-acting plunger pump under the same conditions of lift and pressure. There are three distinct types of these pumps known as the Latta-Martin, Halsey, and Harris or «return-air.»

The Latta-Martin system employs two tanks, side by side, with a valve arrangement controlling the admission and discharge of water and air. In operation the pump is completely submerged and one cylinder fills by gravity while air is forcing out the water from the other. When this cylinder is empty, the air is automatically released, water enters and compressed air is applied to empty the other cylinder. The discharge water flows continuously.

The Halsey system employs a single tank and must be submerged to insure good operation. The tank fills by gravity, and as the water enters it causes the float to rise, which, when near the top of the tank, drops a valve and permits the influx of compressed air to discharge the water. The flow of water is intermittent. Neither the Latta-Martin nor the Halsey system uses compressed air expansively, and as a result there is considerable energy lost.

The «return-air» system overcomes the difficulty of not employing air expansively and in it no floats and no air valves, outside the engine room, are employed and the same air is used over and over again, thus eliminating the effect of clearance. This system employs two tanks and its operation consists in brief of turning air out of one tank and forcing it into the other, and in so doing will draw water into the former and force it out of the latter. The charge of air in the system is so adjusted that when one tank is empty the other is full, and at that moment the switch will be automatically thrown, reversing the pipe action and thereby reversing the action of the tanks. Of all systems of pumping, the Harris is certainly the most economical and efficient. Using the air expansively, all the inherent energy of compressed air is used, and no mechanism being submerged, there is no chance for the system to become inoperative due to breakage or a demand for repairs. This system may be employed for pumping mixtures of sand and water, and operates with a marked degree of economy and reliability.

Power Driven Pumps.— The greatest advantage in the use of the power driven pump, when the air is the driving fluid, lies in the fact that it permits the expansive use of the compressed air, resulting in a considerable saving and economy. Power pumps consist essentially of expansive air engines, which may be either direct connected, belted or geared to some form of duplex or triplex plunger pump, or to the simple, compound or turbine types of centrifugal pump in its various forms. Compressed air is supplied to the air engine from some distant air compressor and this air engine, when specially designed for the use of air involving considerations of air valves and low clearance, operates with efficiency and economy. Where the magnitude of the operation justifies it, the use of the «return pipe» system with expansive engines will, in connection with reheaters, secure the very highest efficiency.

Air Lift.— Opinions differ as to the theory of the air lift. A common air lift is one where we have a driven well in which the water is approximately near the surface. We place in this well a large pipe for the discharge of the water. This is known as the «eduction pipe.» This pipe does not touch the bottom of the well, but is lifted above it so as to admit freely the water through its lower end. Alongside this pipe, either on the outside or within, is a second but smaller pipe, properly proportioned end intended to convey compressed air to a point near the bottom of the eduction pipe. The air pipe is connected with an air receiver on the surface, which is in or near the engine room in which free air is compressed. Before turning on the air the conditions in the well show water at the same level on the outside and inside of the eduction pipe. At the first operation we must have sufficient air pressure to discharge the column of water which stands in the eduction pipe. This goes out *en masse*, after which the pump resumes a normal condition, the air pressure being lowered and standing at a point corresponding with the normal conditions in the well. This is determined by the volume of water which a well will yield in a certain time and the elevation to which the water is discharged. It was first supposed that in all air lift cases the water was discharged because of the aeration of the water in the eduction pipe due to the intimate commingling of air and water. Bubbles of air rising in a water column not only have a tendency to carry particles of water with the air, but the column is made lighter, and, with a submergence or weight of water on the outside of the eduction pipe there would naturally be a constant discharge of air and water. This is known as the Frizell system; and where the lifts are moderate, that is, where the water in the well reaches a point near the surface, it is very likely that the discharge is due to simple aeration.

Most air lift propositions are deep well cases, that is, the water is lifted a distance greater than 25 feet. Aeration will not expel such water, so the idea of piston-like layers of air and water is developed. The economy of the air lift system is in direct proportion to the capacity of the well to form these piston-like layers, and the reason why they are formed is that after the first discharge, there is kept up a constant struggle between the air under pressure and the head of water on the outside of the pipe, each one seeking to enter the lower end of the eduction pipe.

When the air pressure is greater than that due to the head of water, a certain volume of compressed air is admitted into the eduction pipe. The water is at that time moving rapidly, that is, its momentum has been established. The air takes up this velocity and goes upward with the water. If a sufficient quantity of air has been admitted in proportion to the diameter of pipe, and if there is a sufficient pressure in this pipe to prevent the free discharge of the air, it is readily seen how this bubble of air spreads itself across the diameter of the pipe in a piston-like condition. The reason why this piston is not elongated and continuous is that the free discharge of the air, aided by the velocity with which everything in the eduction pipe is moving, causes a fall in the air pressure just sufficient to allow the water head to press the water into the air space, or the open end of the eduction pipe. In other words, as the air pressure is slightly lower, the water pressure, which was nearly equal to the air pressure, becomes a little greater and the piston-like layer of water enters the pipe, shutting off the air. This «chunk» of water rises in the eduction pipe with velocity equal to that of the air, and as it has plugged off the air nozzle, there is a momentary rest, during which the air has a chance to accumulate greater pressure, and just as soon as this pressure overcomes that of the water, the conditions are reversed and another «chunk» of compressed air is discharged into the pipe, shutting off the water for an instant. This process is continuous and as regular as the movement of a pendulum.

As these «chunks» of air approach the surface, they are gradually enlarged, because of the reduced load upon them, and it is likely that before they reach the surface there is a general breaking up of the piston-like layer condition. The Pohlé system of air lift is probably the best known. Sand, grit and small stones are no obstacles in the satisfactory operation of this system. As a matter of fact, in many instances, the capacities of the wells have been increased by opening up the well more thoroughly, by removing sand. Water pumped by this system is purified, due to aeration. The system is not limited as to the quantity of water that can be handled. This will depend upon the capacity of the wells to furnish the water. The height of the lift is unlimited, as well as the submergence.

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Pun, a play upon words alike or similar as to sound, but different as to sense. The pun has been familiar to all literatures, and in ancient times was used even in serious context. This was true also in England of the 17th and 18th centuries. Puns are met with in the tragedies of Shakespeare; in the works of the quaint Fuller; in the discourses of Bishop Andrewes. The divines of colonial America did not lack for them. Mathey Byles won his reputation for wit chiefly through the appositeness and felicity of his puns. Thus, being a sturdy loyalist, he was for a time kept under surveillance by a sentinel whom he called his «observe-a-Tory.» A parishioner called upon him, and Byles, noting his ulcerated jaw, sent him to Copley, the artist, to have his tooth drawn. Among famous English punsters may be cited Sydney Smith, Lamb, Theodore Hook, Wilberforce and, above all, «Tom» Hood, most inveterate and happy of the coterie, who even remarked of a certain undertaker that he appeared anxious to «win a lively Hood.» The pun has frequently been derided as an unworthy form of wit. John Donne is reported to have said that «He who would make a pun would pick a pocket»; and Holmes, in the 'Autocrat,' after denouncing verbicide, gives a pyrotechnic display of excellent puns. It is true, however, that the pun has found advocates in divines, philosophers, statesmen and literati. Many puns convey a weight of meaning which could hardly be secured by sentences of paraphrase.

Punch, a well-known English comic weekly, the most famous journal of the kind. The success of Philipon's Paris 'Charivari' induced a staff of several Englishmen — some, as Douglas, Jerrold, Thackeray, and John Leech, since famous — to organize for the publication of a 'London Charivari,' of which whole pages of text had been set up, when the scheme collapsed. This undertaking had, however, some indirect influence on the subsequent 'Punch.' The idea of 'Punch' appears to have been due originally to Ebenezer Landells, a Northumbrian wood engraver and draughtsman, and to have been developed by Henry Mayhew, a brilliant humorist of the time. «Mr. Punch» was the traditional jester of the puppet-show transformed into «the laughing philosopher and man of letters; the essence of all wit, the concentration of all wisdom.» As finally agreed, Mayhew, Mark Lemon, and Stirling Coyne were to be co-editors, Landells was to find drawings and engraving, and Douglas Jerrold and Gilbert à Beckett were to be among the outside contributors. The first number appeared on 17 July 1841. In two days two editions, each of 5,000 copies, were sold out. After some early vicissitudes, ‹Punch› became an English institution. A list of its writers and artists includes many famous names besides the jovial Lemon and the caustic Jerrold; Thackeray, «Tom» Hood, Charles Lever, «Tom» Taylor, Cuthbert Bede, Horace Smith, Shirley Brooks, F. C. Burnand, Artemas Ward, G. A. Sala, H. W. Lucy; John Leech, H. K. Browne («Phiz»), Sir John Tenniel, George Du Maurier, Stacy Marks, Sir John Millais, Linley Sambourne, and others. The editors have been: Mark Lemon, 1841–70; Shirley Brooks 1870–4; «Tom» Taylor, 1874–80; Sir F. C. Burnand, 1880–1906; and Owen Seaman, 1906—. ‹Punch› has done much to laugh out of court various shams, fads, affectations, and forms of ostentation. In British politics it has remained wholly free from party bias. The present application of the word «cartoon» originated with ‹Punch,› the occasion being the first great exhibition of cartoons for the Houses of Parliament (July 1843), when Mr. Punch appeared with a rival series of sarcastic designs. ‹Punch› has sometimes been unfairly attacked for its insularity. Consult: Spielmann, ‹The History of «Punch»› (1895); ‹An Evening with Punch› (1895), selections from the first 50 years; A. W. à Beckett, ‹The à Becketts of Punch› (1903).

Punch, a beverage, commonly composed of wine or spirits, water, lemon juice, and sugar, with occasionally an addition of some spice, as nutmeg or cinnamon. These are usually mixed in the requisite proportions in a large bowl made for the purpose — hence called the punch-bowl. The beverage is compounded as follows: Squeeze the juice out of three or four lemons into a jug, adding thereto the peel of one lemon cut in slices, 12 ounces of lump sugar, and three and a half pints of boiling water; infuse this mixture for half an hour, then pour into the punch-bowl, and add of rum and brandy rather less than a pint of each. Varieties of punch are called after one of their principal ingredients, gin, milk, orange, raspberry, tea, wine, etc. Punch was introduced into Great Britain from India, and it appears to be so called from the Hindu *panch,* five, which is the usual number of the ingredients.

Punch. See METAL-WORKING MACHINERY.

Punch and Judy, in Great Britain and some European countries, a well-known puppet-show frequently exhibited in the streets. The show of Punch and Judy derives its origin from the Neapolitan Punchinello, but many of its features are purely English. The earliest account of the adventures of Punch and his wife, Judy, is found in a ballad, the date of which does not appear to be anterior to 1795. This account corresponds pretty closely with the representations given in our streets. The show embodies a domestic tragedy, followed by a supernatural retribution, the whole of which is treated in a broadly farcical manner. Punch himself is represented as short and thick-set, with an immense hump upon his back, a wide mouth, long chin, and hooked nose, and wearing a three-pointed cap. His wife, Judy, who is in some respects his counterpart, and his dog, Toby, are important characters in the performance. See also PUPPET-SHOWS.

Pun'cheon, a liquid measure of capacity containing from 84 to 120 gallons. See WEIGHTS AND MEASURES.

Punchinello, pŭn-chĭ-nĕl'ō (from *pulcinello*), an Italian mask or marionette. The Abbate Galiani derives the name from a misshapen but humorous peasant from Sorento, who had received it (about the middle of the 17th century) from his bringing chickens (*pulcinelle*) to market in Naples, and who, after his death, was personated in the puppet-shows of the San Carlino theatre, for the amusement of the people, to whom he was well known. See also PUPPET-SHOWS.

Punctuation, from the Latin *punctus,* «a point,» is the term used to designate the use of certain points, or marks, for the purpose of separating words from each other in sentences and parts of sentences. The convenience of such separation is too obvious at this time to need support by argument, but the fact is, nevertheless, that for many centuries after writing had first been used there was nothing to indicate the pauses, or divide a book into sentences. No attempt to punctuate is apparent in the earlier manuscripts and inscriptions of the Greeks. It was in Alexandria that punctuation originated, when that city was the centre of ancient learning. The open space to the left of a line which indicates the beginning of a paragraph made its appearance on papyri at Alexandria. The early signs intended for punctuation were at first used in poetry only, to enable readers to comprehend the meaning hidden in obsolete words and involved and difficult verses. Ages passed, however, before any form of punctuation became general, and it was not until the 9th century after Christ that the division of sentences by full-points and colon and semi-colon marks, took place. The comma was the same as to-day, a large dot or double dot indicated the full-stop, and a high dot stood for a colon or semi-colon.

Modern punctuation has no hard and fast rule, and this is especially the case in English, writers of standing exemplifying the broadest latitude in this respect. Some long sentences in standard works are carried through without a comma, while in books of equal repute commas are plentifully used where no pause is apparent. Properly speaking a comma signifies a slight turn in a sentence; the semi-colon is used where there is a change too important for a comma, and the full-point or period marks the close of a sentence. The colon is not often used, and when it is used it is where, as a rule, a full-point would be better. This may also be said of the semi-colon. There is a growing tendency to uniformity in the use of punctuation.

Pun'dit, or **Pandit,** an Indian title for men who devote themselves to the pursuit of learning, especially on religious subjects. It corresponds with the modern title of «Doctor.» It is especially applied to certain men who in the 19th century after being instructed by the English in the science of geodesy have explored and surveyed Tibet, and other areas of Asia generally inaccessible to Europeans. The most notable of them were Mohammed i Hamid, who went (1863-4) over the Karakoram Pass to the Yarkand River; the famous Naing Singh, who, between 1865 and 1875, brought back valuable results from his travels in Tibet, and discovered the northern springs of the Indus; Mirza Sudja, who (1868-9) crossed the Little Pamir to Kashgar and Ley; Haider Schah, who in 1870 made an expedition to Faizabad in the valley of the Oxus, and later explored the mountain ranges between Cabul, Bokhara, and East Turkestan. Consult: Garbe, 'Indische Reiseskizzen' (1889).

Punic (pū'nĭk) **Wars**, in ancient history, the general name applied to three great wars between the Romans and the Carthaginians. The first (264-241 B.C.) was for the possession of Sicily, and ended by the Carthaginians having to withdraw from the island. The second (218-202 B.C.), the war in which Hannibal gained his great victories in Italy, was a death struggle between the two rival powers; it ended with decisive victory to the Romans. The third (149-146 B.C.) was a wanton one for the destruction of Carthage, which was effected in the last-named year.

Pu'nica. See POMEGRANATE.

Pun'ishment, a term which originally signified pain inflicted on or endured by a person as a satisfaction or atonement by him for some offense which he had committed; it embodied, in fact, the idea of retaliation, and this appears to have been the earliest notion of punishment which most nations possessed. It occurs among the early Greeks; the Romans recognized it in the laws of the Twelve Tables; and it was the principle of the well-known provision of the Mosaic law, «an eye for an eye,» etc. In this country punishment by death is called *capital punishment*. See CAPITAL PUNISHMENT; LAW, CRIMINAL; PRISON; etc.

Punjab, pŭn jäb′, or **Panjab** (Persian, «Five Waters»), an extensive territory in the northwest of Hindustan, formerly under the dominion of the Sikhs, but in 1849 annexed to British India. It is so called from its position, being intersected by the five great rivers which unite to pour their waters into the Indus. In 1901 the northwestern part of the Punjab was separated to form a chief commissionership under the government of India (see NORTHWEST FRONTIER PROVINCE). The lieutenant-governorship as thus limited is bounded on the east by Kashmir, Tibet, and the river Jamna; on the south by Sind and Rajputana, the river Sutlej being in part a boundary river; on the west by Baluchistan and Northwest Frontier Province; on the north by the Northwest Frontier Province. For administrative purposes it is divided into four divisions (Delhi, Jalandhar, Lahore, and Rawal Pindee). Lahore is the capital, with a population of 202,964. Delhi has a population of 208,575, while Amritsar, the sacred city of the Sikhs, has 162,429. Simla, the mountain capital, is within the Province, and is the residence of the viceroy during the hot season. Murree is the summer headquarters of the military command. The total area of the province is 97,209 square miles, with a population of 20,330,339. The area of the Native States is 38,299, with a population of about 4,500,000.

General Description.—The province of the Punjab is a triangular tract of land between the Sutlej and the Indus, and, with the exception of the hill country on the slopes of the Himalayas, it is a great alluvial plain. On the northeast side is the margin of the Himalayas, on which there are beautiful sanitaria, or hill stations:—Simla (the mountain capital of India), Dagshai, Sabathu, Kassauli, Dharmsala, Dalhousie, and Murree, the military headquarters of the province. The country between Jhelam and the Indus is known as the salt range, as it contains inexhaustible mines of rock salt which have been worked for many centuries. It is abundantly irrigated by six rivers. These rivers (proceeding from west to east) are the Indus, the Jhelam (ancient *Hydaspes*), Chenab (ancient *Acesines*), the Ravi (ancient *Hydraotes*), the Beas (ancient *Hyphasis*), and the Sutlej (ancient *Hesudrus*). The Jhelam and Chenab unite their waters, and then are joined by the Ravi; the united stream is then augmented by the Sutlej, which has previously received the Beas. The combined waters of these rivers form the Panjnad, which joins the Indus near Mithankot. The rivers of the Punjab divide it into five districts, or *doabs* (countries between two rivers): namely, the Sind-Sagar Doab, between the Indus and Jhelam; the Jech Doab, between the Jhelam and Chenab; the Rechna Doab, between the Chenab and Ravi; the Bari or Manja Doab, between the Ravi and Beas; and the Jallandar Doab, between the Beas and Sutlej. Of these the first is by far the largest, but also the most sterile and least inhabited, abounding with bare eminences and rugged declivities, interspersed here and there with rich and fertile valleys. The second is mostly level, and has been described as «a sterile waste of underwood,» the abode of shepherds, and scantily irrigated; the Rechna Doab is bare and neglected, though susceptible of high cultivation; the Bari Doab, though bare, has a large surface under cultivation, and is the most populous and important of all, containing the large towns of Amritsar, Multan, and Lahore; while the Jallandar Doab is highly cultivated, well peopled, and excelled in climate and productions by no province in India. Speaking generally, the plains east of Lahore are the most fertile, wealthy, and populous of the province, and the granary of the Punjab; while those on the west present a striking contrast. The soil of the level country varies remarkably from stiff clay and loam to sand, mixed with each other in variable proportions, and with vegetable matter; besides which, carbonate and sulphate of soda are sometimes mixed with it in such quantities as to render the land almost worthless. The mineral wealth of the Punjab is almost confined to its rich deposits of rock salt. The climate is hot and dry, and little rain falls, except in the higher country and under the influence of the Southwest monsoon. The part of the province to the east of Lahore can be cultivated in most seasons without irrigation, but owing to this its crops are much more likely to fail from a deficiency of rainfall than those of the western irrigated tracts. The summer heat is very great, and in the early part of January sharp frosts are common.

Vegetation, Agriculture.—Wood is scarce, except upon the hills. In the west considerable areas are occupied by date-trees; and palms of other species, banyans, and other trees are found here and there. The area under forests is over 4,250,000 acres. About 28,000,000 acres of the remainder are under cultivation, and over 20,000,000 acres more are available for cultivation. The principal grain crops are wheat, barley, rice, buckwheat and millet, pease, vetches, and mustard: sesamum and other oil seeds, turnips, carrots, onions, cucumbers, and melons. Indigo and sugar are exported. The tobacco plant grows luxuriantly, especially about Multan, and opium has been grown pretty extensively. About 7,750,000 acres are under wheat, and over 750,000 under rice. The total irrigated area exceeds 9,000,000 acres, of which more than half is irrigated by canals. Among the fruits are the date, orange, fig, vine, apple, mulberry, banana, and mango. The live-stock include sheep, cattle, horses, and camels; buffaloes are common.

People.—The population of the Punjab is composed of various races, the chief of which are the Jats, Rajputs, and Pathans. The Jats form the bulk of the agricultural peasantry, and are tall and athletic, with handsome, open countenances, long beards, and fine teeth. The people, generally, are in physical respects superior to those of Bengal. The native states subordinate to the Punjab government are thirty-six in number. Thirty-one are Hindu and five Mohammedan. The most important is Kashmir, the next Patiala. The Mohammedan state of Bahawalpur is the next. The next in order are Kapurthala, Mandi, Sarmur, Faridkot, and Malarkotla. The other states are insignificant in rank and consequence.

Religion.—The religion of the Sikhs, which is the national religion of the Punjab, was founded by Nānak, who was born A.D. 1469. The Golden Temple at Amritsar is the centre of the faith and the guardian of the sacred book known as the Adi Granth (see SIKHS). By the census of 1891 the distribution of the population according to religious profession was as follows: 12,915,643 Mohammedans, 10,237,700 Hindus, 2,100,000 Sikhs, 53,909 Christians, 45,683 Jains, 6,236 Buddhists, 412 Parsis, 33 Jews, and 30 others. Of the Christian population 27,915 belonged to the Church of England, 12,083 were Presbyterians, 7,113 were Roman Catholics, the remainder being Baptists, Methodists, etc. The American Presbyterian Board of Missions has important stations at Lahore, Ludianah, and Umballa. Lahore is the seat of both a Church of England bishop and a Roman Catholic bishop. The Mohammedans form a very large part of the population of the Rawal Pindee and Multan divisions. The Hindus predominate in the easterly divisions and in the mountainous district of Kangra. The Sikhs reside chiefly in the centre and east of the province and constitute the mass of the gentry. The few Buddhists of the Punjab are almost entirely confined to the small Spito district in the extreme northeast. The Pathans and Baluchis are the most numerous of the Punjab Mohammedans by race, but the Mohammedan strength consists largely in converted Hindus belonging to the Jat and Rajput tribes. The Hindu Jats form a large proportion of the population.

Language and Education.—The chief languages spoken in the Punjab are Punjabi (known as Gurmukhi), Hindi, Sindhi, Jataki, Kashmiri, Pushtu, Persian, and English. Since the country came under British rule elementary education has received much attention. The total number of educational institutions in the Punjab in 1899-1900 was 7,867, with a total of 262,319 scholars. Of the higher educational institutions of the province the following may be mentioned:—the Punjab University at Lahore; Lahore Government College; Oriental College; St. Stephen's College, Delhi; Lahore Medical School; St. Thomas College, Murree; the Khalsa College, Amritsar; Bishop Cotton School, Simla; and the Lawrence Military Asylum, Sanawar.

Manufactures and Trade.—The manufacturing industry of the Punjab is chiefly confined to the larger towns. Amritsar, Lahore, Multan, and Shujabad are distinguished for their silk and cotton fabrics, and the silks of Multan called *kais,* and chiefly used for scarfs, possess a strength of texture and brilliancy of color for which they are much prized in the Indian markets. The shawls of Lahore, too, rank only second to those of Kashmir. Brocades, tissues, and carpets resembling the Persian are also manufactured in the capital. In the east of the Punjab white cotton goods are prepared of a stronger and more durable texture, as well as cheaper, than those of British manufacture. The Punjab enjoys from its position an extensive transit-trade. The imports comprise sugar, spices, and other groceries, dye-stuffs and cottons, woolen and silk fabrics, metals and metallic utensils, cutlery, precious stones, ivory, glass and cochineal, asafætida, safflower, fresh and dried fruits, wool, horses, etc. The exports —partly of home produce, partly in transit— comprise grain, *ghee,* hides, wool, silk and cotton fabrics, carpets and shawls, raw silk and cotton, indigo, tobacco, hardware, horses, etc.

Government and Revenue.—The province is under a lieutenant-governor, assisted since 1897 by a legislative council of nine members. The most important item of revenue is the land-tax, which, on the average, yields a net revenue, after deducting charges, of nearly £2,000,000; besides there are excise duties on spirits and drugs, duties on stamps, etc. The financial condition is so favorable that there is often a clear surplus of revenue over expenditure of £2,500,000. About one-half of the whole cultivated area of the Punjab is tilled by owners, and about one per cent. by tenants paying a nominal or no rent. Of the remaining area one-fifth is cultivated by occupancy tenants, and the rest is held by tenants-at-will, a class increasing in numbers from year to year. Rents vary from 5 annas to 40 rupees per acre, the average being about 2 2-3 rupees. On about two-thirds of the land held by tenants-at-will the rent is wholly or partly paid in kind, and the average rent payable in kind is for the whole province about two-fifths of the produce. Nearly 5,000,000 acres are under mortgage.

Army and Police.—The Punjab forms a military district called «The Northern Command,» under a lieutenant-general with headquarters at Rawal Pindee. The military authority of this officer extends to the Northwest Frontier Province. The military cantonments are Rawal Pindee, Peshawar, Noroshera, Abbottabad, Sialkor, Jhelum, Lahore, Jullundur, Sirhind, Umballa, Forozepore, Kohat, Bannu, and Murdan under a lieutenant-general. The military force stationed in the Punjab in 1900 consisted altogether of 68,806 men. Of cavalry there were 11,893, of infantry 50,504, of artillery 6,120, with some engineers, etc. There were thus more troops in the Punjab than in any other division of India. The police force is stated to be in a most effective condition. It numbers about 20,000 men, divided into two divisions, the Trans-Sutlej and the Cis-Sutlej. Almost all the police are armed either with swords or guns. The Punjab has a chief court with five judges, two of whom are natives— and four temporary judges.

History.—The Punjab plays an important part in the history of Hindustan and British India. It was invaded in 327 B.C. by Alexander the Great, who defeated Porus at Mong in Gujerat and overran the whole country. In 1022 it was overrun by the troops of Mahmūd of Ghazni, whose successors held the country for 170 years, making Lahore the seat of their government. In 1193 it passed by conquest into the hands of Mohammed Ghori, and Delhi became the capital. After his death the country was ruled by a succession of turbulent chiefs, principally Afghans, till at length in 1526 Baber, the founder of the Mogul Empire, having obtained possession of the country, ascended the throne, and established a dynasty whose sway prevailed for about two centuries, during which the Sikhs were rising into importance. In 1738 Nadir Shah overran the Punjab, and in the following year he defeated the Mogul army at Karnal and sacked Delhi. The Sikhs were utterly defeated by the Afghan conqueror Ahmed Shah Durani in 1762, and the Moguls nominally ceded the Punjab to him. The Durani dynasty maintained its ascendency till the beginning of the 19th century, when the Sikhs under Ranjit Singh began their career of conquest. In 1818 this renowned chieftain stormed Multan and took Peshawar—in the following year conquering Kashmir and Derajat west of the Indus; and in 10 years he succeeded in establishing his power over the whole country. In 1839 Ranjit Singh died. His son Khorak Singh quietly succeeded, but died of a decline a few months after his father, on which Shere Singh, a natural son of the great Ranjit, assumed the sovereignty, but was assassinated 15 Sept. 1843. Dhulip Singh, the reputed son of Ranjit Singh, succeeded his brother. This young prince was converted to Christianity and retired on a princely pension to England, where he died. But from the close of 1843 to the period of its annexation to British India the government was in abeyance, or, what is worse, in the hands of an ignorant, bloodthirsty, rapacious, and insubordinate army. At length it became manifest that the Sikhs of the Punjab were preparing for an irruption into the territories protected by the British on the east of the Sutlej. In the end of December 1845, the Sikh forces passed the Sutlej into the territories protected by the British, with a most formidable train of artillery, but they found themselves completely worsted after the hard-fought actions of Mudki, Ferozeshah, Aliwal, and Sobraon. Lahore and other stations were afterward occupied by British troops; the Jallandar Doab, between the Sutlej and Beas, was permanently ceded to the British; and the province of Kashmir, and the other provinces of the Himalayas, were vested in the Rajah Gholab Singh. In 1849 a conspiracy between several disaffected chiefs and the Afghans resulted in further hostilities against the British, Multan being the centre of their operations. The indecisive battle of Chillianwalla was followed by the capture of Multan in January, and the victory of Gujerat in February 1849, since which period the former territories of the Sikhs have formed an integral part of the British Empire. The most important subsequent event in the history of the province was the Indian Mutiny, when the Sikhs were loyal to the British government, and the present Sikh regiments of the British native army form the most important section of the military strength of the empire, the Sikhs and the Gurkhas being esteemed by many critics the finest soldiers in the world. After the suppression of the Mutiny the province was erected into a lieutenant-governorship under Sir John Lawrence, the distignuished statesman.

Bibliography. — Consult Cunningham, 'Archæological Survey of India,' Vol. XIV. (London 1882); Gore, 'Lights and Shades of Hill Life in the Afghan and Hindu Highlands of the Punjab' (London 1895); Latif, 'History of the Punjab from the Earliest Antiquity to the Present Time' (London 1896); Medlicott, 'Sketch of the Geology of the Punjab' (Calcutta 1888); Prinsep, 'History of the Punjab'; Griffin, 'The Rajas of the Punjab' (2d ed., London 1872); Honigberger, 'Thirty-five Years in the East'; Edwardes, 'A Year on the Punjab Frontier'; Clark, 'Thirty Years of Missionary Work in the Punjab.'

Punj'nud, or **Panjnad** ("the five rivers"), a stream of the Punjab, formed by the Sutlej, Beas, Ravi, Chenab, and Jhelam, whose waters it carries to the Indus (q.v.), about 490 miles from the sea near Mithankot. The Punjnud bounds Punjab and Bahawalpur in part of its course.

Punk'ah, a large fan used in India and other hot countries for ventilating rooms. It consists of a movable frame of wood covered with canvas and suspended from the ceiling. It is pulled backward and forward by means of a cord, and thus causes a current of air in the apartment.

Punnah, pŭn'ạ. See PANNA.

Puno, poo'nō, Peru, (1) town, capital of the department of Puno; on the west shore of Lake Titicaca, 12,870 feet above sea-level, and 90 miles east by south of Arequipa. It has two churches, a college, and a hospital. A railway runs to Arequipa and to Mollendo on the Pacific. Pop. 6,000. (2) The department of Puno; area, about 41,198 square miles, is mountainous. The principal crops are potatoes and barley, but it is particularly distinguished by the extent of its pastures, cattle raising being the chief occupation. Its principal exports are the wool of the sheep, llama, alpaca, and vicuña, and some cascarilla bark from the valley of Carabaya. Pop. about 540,000.

Punt, poont, an ancient country on the Red Sea, whether in Asia or Africa is disputed. The country is mentioned a number of times in the Egyptian hieroglyphics, and such records show that the Egyptians obtained from Punt ostrich feathers, leopard skins, gold, incense, ivory, precious woods, and various ornaments. There are good reasons for locating Punt where is now Somali Coast and Abyssinia. Accounts are given of journeys to Punt, undertaken by command of monarchs. Queen Hatshepsut sent thither a whole fleet, and the account of the voyage, the persons and places seen in Punt were recorded on the walls of the Temple of Deir el-Bahri. Consult: Müller, ‘Asien und Europa’; Naville, ‘Deir el-Bahri’; Erman, ‘Life in Ancient Egypt.’

Punt, an oblong flat-bottomed boat used for fishing and shooting in shallow waters. The most common mode of propulsion is by pushing with a pole against the bottom of the river, or stream, a process which is hence called punting.

Punta Arenas, poon'tä ā-rä'näs, or **Sandy Point,** Chile, port and capital city of the territory of Magellan, at the extreme end of Patagonia (lat. 53° 10' S.), and lying in a plain bounded by the rivers Las Minas, on the north, and La Mano, on the south, with wooded hills back of the river. The city is Chile's only free port and is a coaling station for steamers passing through the Strait of Magellan. The surrounding country produces rye, barley, potatoes, etc., and the forests supply timber which is exported to the Falkland Islands. The seal-fisheries are considerable. The city has banks, stores, hotels, and an opera house. Pop. (est.) 6,400. The site was made a penal colony in 1843, and a town was founded in 1849.

Punxsutawney (Punk-so͝o-tá̤-nĭ), Pa., city in Jefferson County; situated on Mahoning Creek and on the Pennsylvania & N. W., the Buffalo, Rochester & Pittsburg, and the Buffalo & Susquehanna R.R.'s; about 70 miles east of Pittsburg. It is the business centre of a great bituminous coal and coke region and the headquarters of the second largest producers of bituminous coal and coke in the United States. There are also large iron furnaces and numerous smaller industries. Punxsutawney is an Indian name signifying «Mosquitotown» or «Gnatopolis,» the Indian word for blood-sucking insects of the genus *Culex* being «ponki.» It was organized into a borough in 1849. Its growth since 1890, when it had a population of 2,792, has been rapid. Pop. (1900) 4,375; (1910 census) 4,900, and with the borough of Clayville immediately adjoining it on the west, about 8,300. W. O. SMITH.

Pupa, the name applied to the second stage in the metamorphosis of insects. In the typical complete or holometabolic insects, exemplified by beetles, the *Lepidoptera*, flies, etc., the pupa stage is marked by quiescence and rest, and thus presents a contrast to the preceding and active larval stage. During the pupa stage the elements of the larval form are being remodeled into that of the *imago* or perfect insect, which in due time emerges from the pupa case. An insect may remain in the pupa stage from a few hours or days to weeks, months, or even years.

The pupæ of the hemimetabolic insects, or those which undergo an incomplete metamorphosis (such as grasshoppers, locusts, bugs, etc.), are called nymphs, and differ from the perfect insect, which they resemble in form, chiefly in the absence or rudimentary nature of the wings. These latter structures in the pupa state of hemimetabolic insects may generally be perceived to be in course of formation, the perfect insect or imago state being characterized simply by the full development of the wings. See INSECTS; METAMORPHOSIS.

Pu'pin, Michael Idvorsky, American scientist and inventor: b. Idvar, Hungary, 4 Oct. 1858. He came to America in 1874, was graduated at Columbia in 1883, and as the first American holder of the John Tyndall Fellowship of Columbia studied physics and mathematics at Cambridge University and under the famous von Helmholtz at the University of Berlin, here taking his degree of Ph.D. He returned to teach at Columbia, was appointed adjunct professor of mechanics there in 1892, and professor of electro-mechanics in 1901, which position he now (1904) holds. He is the inventor of an improvement in the telephone by means of which it is confidently expected telephoning across the Atlantic will soon be rendered practicable. Professor Pupin first announced the theory underlying his invention in March 1899, and brought his system to such perfection that in 1901 it was acquired by the Bell Telephone Company and by German telephone interests for practical trial. In June 1903 the device had been found, in Germany, to operate successfully over a cable more than 260 miles in length, and its applicability to submarine cables was considered established. His invention not only makes it possible to telephone much further than before, but renders all messages more distinct. It consists, essentially, of self-inducting coils of wire placed at intervals about the wire which transmits the sound, thus preserving the vibrations a greater distance. He has published: ‘Thermodynamics of Reversible Cycles in Gases’; etc.

Puppet-shows, an amusement or entertainment popular in Europe. One of the most common classes of puppets is called, in French, *marionnettes.* These are images of the human figure moved by wires or threads on a stage, and made to perform little dramas, the dialogue of which is carried on by the person in concealment, who moves the figures. In the common street performance in England of Punch and Judy (q.v.), however, the performer puts his fingers in the figures. Puppet-shows were common among the Greeks, from whom the Romans received them. Xenophon, Aristotle, Gellius, Horace, and others mention them. Such exhibitions, which are so pleasing to children and the uneducated, naturally passed through various degrees of perfection in different ages, and even now exhibitions of puppets are common in some countries which display great mechanical ingenuity. Clocks often display movable puppets, and it is not unfrequent in Germany to find on ancient town-clocks puppets which move whenever the clock strikes. In 1674 there was a puppet opera at Paris, which met with great applause. At present there are two theatres in Paris for puppet-shows, and they still continue to be performed in several large cities of Italy. In Germany, also, excellent puppet-shows are sometimes seen, but they are there hardly ever stationary, and are not by any means so much patronized as in Italy. There is a puppet-show in the Italian colony in New York, which is much patronized by Americans.

Puracé, poo-rä-sä', a volcano of the Andes in Colombia, 20 miles east of the town of

Popoyan. Eruptions have occurred several times; the town of Puracé at the base of the mountain was destroyed by the eruption of 1827; and the top of the volcano blown off and its height reduced to 15,420 feet by the eruption of 1849. It is still active, and hot vapors issue constantly from the crater.

Puranas, poo-rä'nas. See SANSKRIT LANGUAGE AND LITERATURE.

Purbeck (pėr'bĕk) **Beds**, a series of geologic beds or strata consisting of limestones, clays shales and sandstones which in England form the uppermost member of the Jurassic system (q.v.). They are named after the Isle of Purbeck on the southeast coast of Dorsetshire where they are exceptionally well developed and yield among other building stones a limestone, susceptible of a good polish, which is known as Purbeck marble. The «Isle» is in fact a peninsula 12 miles long by 7 miles broad, almost completely surrounded by sea. The Purbeck beds appear in a chalky ridge which traverses the island from west to east.

Purbeck, Isle of. See PURBECK BEDS.

Purcell, pėr'sĕl, **Henry**, English composer: b. London 1658; d. 21 Nov. 1695. He was the son of a musician of the chapel-royal, who left him an orphan in his 6th year. He was admitted a chorister in the king's chapel, where he studied music under choir-master Cook and his successor Pelham Humphrey, and afterward under Dr. Blow. In 1676, when only 18, he was made organist of Westminster Abbey, and six years afterward was appointed to fill the same office at the chapel-royal, St. James. From this period his fame increased rapidly, his anthems and other church music being popular in all the cathedrals of the kingdom; nor were his compositions for the stage and music-room less successful. He composed music, religious and secular, with equal facility; and with respect to chamber music his compositions superseded all prior productions. Of his numerous works his 'Te Deum' and 'Jubilate' were composed for the celebration of St. Cecilia's Day, 1694. Of his instrumental music a collection was published two years after his decease, and comprised pieces in four parts, for two violins, tenor and bass. Many of his songs were published after his death under the title of Orpheus Britannicus. 'Ye Twice Ten Hundred Deities,' contained in this collection, is considered the finest piece of recitative in the language; while his music in 'King Arthur' has maintained its popularity undiminished till our own day. In 1695, the year of his death, he set to music 'Bonduca,' an opera altered by Dryden from Beaumont and Fletcher; but his chief opera is 'Dido and Æneas' (1680). He was the author of a vast variety of catches, rounds, glees, etc., remarkable both for their melody and for their spirit, humor, and originality. He was buried in Westminster Abbey. A splendid edition of his works is published by the Purcell Society, founded in 1878. An earlier edition of his sacred compositions is that of Novello (1829-32). Consult: Cummings, 'Life of Henry Purcell' (1882).

Purcell, John Baptist, American Roman Catholic archbishop: b. Mallow, County Cork, Ireland, 26 Feb. 1800; d. Brown County, Ohio, 4 July 1883. He came to the United States in 1818, was educated at Mount Saint Mary's College, Emmitsburg, Md., received minor orders, and later studied at Saint Sulpician's College in Paris. He was ordained in 1826 and in 1827 appointed to the chair of philosophy in Saint Mary's College, of which he became president in 1828. In 1833 he was consecrated bishop of Cincinnati, and at once set about the improvement of the diocese under his charge, and in 1846 the number of churches under his control had increased from 12 to 70, the number of Roman Catholics from 6,000 to 70,000. He founded schools and academies, built a convent for the Ursulines, and in 1847 the diocese of Cleveland was formed out of that of Cincinnati at his request and placed in charge of another prelate. In 1850 he was made an archbishop and in 1851 received the pallium from the Pope's own hands. He founded Mount Saint Mary's of the West, destined to become one of the leading theological seminaries of the country, and in 1855 presided over his first provincial council. New sees were formed from his diocese in 1868, but though their creation had limited his diocese in extent, it still contained 140,000 Roman Catholics. He attended the Vatican Council in 1869 and celebrated his golden jubilee with great rejoicing among his people in 1876. In 1879, however, his hitherto unbroken prosperity was interrupted. His brother Edward had been appointed his vicar-general and the financial affairs of the diocese had been left by the bishop entirely in his brother's care, trusting implicitly in the latter's financial ability, which was unfortunately as little as the bishop's own. When the crash, rendered inevitable by faulty business methods, came, Edward died broken-hearted. The indebtedness reached nearly $4,000,000, and the crisis came at a time of general financial panic. The bishop, however, was never accused of any dishonesty, though the unwisdom of his confidence in his brother was widely criticised. His own light regard for the value of money was well known, as he had served as bishop for 25 years before he accepted even the «cathredraticum» of $5,000 a year, and when paid it usually was given away before night. He tendered his resignation in 1880, but it was not accepted though he was given a coadjutor. At his death the Roman Catholics in his original diocese numbered half a million. He published a series of text-books for the use of Roman Catholic schools in his diocese.

Purchas, pėr'chas, **Samuel**, English author and Anglican clergyman:: b. Thaxted, Essex, about 1575; d. London September 1626. He was graduated from Cambridge, took holy orders, was vicar of Eastwood, Essex, 1604-13, and in 1614 became rector of Saint Martin's, Ludgate, London, where he remained until his death. He published in 1613 'Purchas his Pilgrimage, or Relations of the World and the Religions Observed in All Ages and Places,' supplemented in 1625 by 'Purchas his Pilgrimmes' in four volumes. The first is his own work and the latter a collection of the narratives of different travelers, edited by him. The latter was illustrated with maps, and the edition of 1626 was supplemented by a fifth volume. It was a work of great value in its day, giving accounts of travels in Europe, Asia, Africa, and America, and was soon imitated. It is valuable to-day as revealing the ideas prevailing in England at that time concerning the rest of the world at large. He also wrote: 'Microcosmos, or the History of Man' (1619); 'The King's Tower and Triumphal Arch of London' (1623).

Purdue University, the Indiana State college of agriculture and technology at Lafayette. It was established under the land grant act of 1862; and in 1869 was named for John Purdue who gave $150,000 and 100 acres of land to the State for the institution. It was first opened to students in 1874. Its present organization includes six schools: (1) the School of Mechanical Engineering; (2) the School of Civil Engineering; (3) the School of Electrical Engineering; (4) the School of Agriculture; (5) the School of Science; (6) the School of Pharmacy. The regular courses extend over four years; in addition the School of Agriculture offers a special two years' course, and a short course of two winter terms; and the School of Pharmacy also offers a two years' course. In 1902 a course in telephonic engineering was added. The degrees conferred are bachelor of science, and graduate in pharmacy. Graduate work is provided for and the degrees of master of science, mechanical engineer, electrical engineer, civil engineer, and analytical chemist are given to graduate students. Instruction in military science and tactics is a part of the curriculum, and all men students are expected to join the military company for two years. The college is coeducational, women entering mostly the schools of Science, of Pharmacy, and of Agriculture. The grounds comprise 180 acres, 50 of which are used as the university campus, the remaining 130 being devoted to the experimental farm for the School of Agriculture. In 1902 a new agricultural building was completed furnished with the best modern apparatus, in 1903 the Eliza Fowler Hall was completed, containing the auditorium and the offices of the president; other buildings of importance are the engineering building for the departments of Mechanical and Civil Engineering, the electrical building, Science Hall, the veterinary infirmary, Purdue Hall, and Art Hall. The laboratories are all well equipped with modern scientific appliances, the equipment of the School of Mechanical Engineering including a locomotive testing plant. The library contains (1910) 30,000 volumes. The agricultural experiment station is also connected with the University, and farmers' institutes are organized throughout the State. Tuition is free for residents of the State; the income is derived mostly from the land grant fund of 1862, from the national appropriation and from the State tax; in 1910 it amounted to $492,000. In 1910 the students numbered 1,867; the total number of graduates 3.539. Its rank among schools of technology is high, and it holds an influential place in the educational system of the State.

Pur'gatives, cathartics; medicines for evacuating the bowels. See CATHARTIC; CONSTIPATION.

Pur'gatory, according to the doctrine of the Roman Catholic Church, a state or place in which the souls of those who depart this life in the grace of God suffer for a time, in expiation of their venial transgressions or in undergoing the penalty due to mortal sins, the guilt and eternal punishment of which have been remitted. Hence purgatory is not a place or state of probation: for the souls in purgatory the time of probation is past, and they are already assured of their everlasting bliss in heaven, though as yet they are not sufficiently pure and holy to be admitted to the vision of God. The dogmatic teaching of the Church goes only so far as to declare that, (1) there is a purgatorium (place of purification), and (2) that the souls therein are aided by the prayers of their brethren on earth. But though the definitive teaching of the Church stops here, the speculations of divines, the meditations of spiritual men, and the beliefs of the general mass of the faithful go much further, and have developed an idea of purgatory which is very much more definite. Thomas Aquinas and Suarez, among the greatest lights of the theological schools, teach that instantly after passing out of the present life, the faithful souls are cleansed from the stains of all venial sin by their turning with perfect love to God; at the same time the debt of the temporal penalties of sin, whether mortal or venial, has still to be paid. It is the common belief of the Western Church that the purgation is by material fire, and the teaching of theologians is that the purgatorial pains are very terrible. While confessedly the doctrine of purgatory is not clearly and unequivocally deducible from any passage of the universally accepted books either of the Hebrew or the Christian Scriptures (for Maccabees is not received by all as canonical, and passages of the New Testament which Catholics believe to point decisively to this doctrine have no such signification for Protestants), it is admitted on all sides that in the very earliest church liturgies that are extant are found forms of prayer for the dead, and that the existence of an intermediate state after death is taught by the Fathers both Eastern and Western with practical unanimity, so far at least as to admit that the dead can be aided by the prayers of the living.

Purifica'tion, in the Jewish ceremonial law, a bodily cleansing with water accompanied by rites more or less elaborate according to the nature of the uncleanness from which the person was to be purified: this physical cleansing being regarded as emblematical of an inward spiritual purification. For different occasions of purification and different rites, see Leviticus xi. 25–40, xv. 1–15, xv. 18, Numbers xix. Similar rites of purification are common to pagan religions whether of ancient or modern times. In the ritual of the Roman Catholic Church, the rinsing of the chalice after communion and the ablution of the fingers of the celebrant after the same are called a purification.

Purification of the Blessed Virgin Mary, Feast of the, a festival observed in the Roman Catholic Church on 2 February: in the calendar of the Episcopal Church in the United States as well as in that of the Established Church of England the Purification of the Virgin Mary is entered for the same day, and in the Book of Common Prayer there are collect and lessons for the day of "the Presentation of Christ in the Temple, commonly called the Purification of Saint Mary the Virgin." The events commemorated by the Church on this day are those recorded in the gospel of St. Luke, ii. 22–39, namely, the going of the Virgin to the Temple 40 days after the birth of her son, for her ritual purification after childbirth, according to the prescriptions of Leviticus xii.; the presentation of the babe to the Lord; and the prophecies of Simeon and Anna. The Christian festival of the Purification was solemnized by the Church at least as early as the end of the 6th century. It is customary on this day, in Catholic countries, for the people and clergy to form processions, each one carrying a lighted candle, signifying the light which the Redeemer brought into the world.

Purifying Apparatus (Electrolytic), for purifying liquids, especially water, for industrial, city and town purposes; a recent invention is an improved apparatus and system for the purification of sewerage and water supply. After several years' experimenting with various metals for an electrode to coagulate the impurities in water (organic and inorganic) it has been found that certain metals are capable of producing while under the action of an electric current immersed in the liquid to be purified, in the form of a sheet or plate, an insoluble hydroxid of the chlorides and sulphates held in solution, which are set free by the action of current passing through the liquid (see ELECTROLYSIS); hydrogen being evolved at the cathode and oxygen at the anode, which destroys the animal and vegetable life, leaving the water clear, free from odor and disease-breeding germs, sparkling, with a pure water taste (see DISTILLATION). For municipal supply, means are provided for the generation of electricity by either hydraulic or artificial power, using large basins for the water to flow through containing the electrodes, which purifies on its passage out of the basin into a coagulating section, being provided with means to retard the suspended matter, allowing the water to flow down an inclined weir for the purpose of aeration, into another compartment of the basin containing screens, which clarifies it free from all sediment, thence to storage reservoirs; occupying small space as compared to sand bed filters and automatic in operation. The apparatus for potable and industrial use consists of vessels capable of working under high pressure as for boiler feed purposes, one of which contains the electrodes or a series of them for very large supply; the electrodes being connected to a suitable source of electric supply, the vessels being provided with air-valves and insulators to prevent the grounding of the current, and connected to other vessels by suitable conduits to remove the suspended matter, thus permitting a constant flow of the water through the apparatus, requiring small space and installed at any convenient point that the water can be conveyed to. A special feature of the device is the means employed to reduce the consumption of the electric current which has been one of the chief sources why heretofore this method of purifying liquids by electrolysis has not been commercial. The theory of using electricity to purify liquids has long been known from a laboratory standpoint, but the methods and electrode used by this company have established the practical and commercial value of this system for the purification of liquids by electrolysis, on a large scale.

WILLIAM R. CHIPMAN,
Chief Engineer Chipman Electric Purifying Company of New York.

Purim, poo'rĭm, the Festival of Lots, which was instituted by Mordecai (Esther ix. 27–x. 3), and is celebrated to this day by the Jews on the 14th and 15th of the month Adar (March), in commemoration of their wonderful deliverance from the destruction with which they were threatened by Haman. On these festive days the book of Esther is read, presents are interchanged, and gifts are sent to the poor. The great popularity of this festival in the days of Christ may be gathered from the following remark of Josephus: "Even now all the Jews that are in the habitable earth keep these days as festivals and send portions to one another." It is supposed that it was this feast which Jesus went up to celebrate at Jerusalem (John v. 1). It is universally celebrated by the large Hebrew population in the United States.

Puritan City, a name applied to Boston, Mass., referring both to the early settlers and the characteristics of its modern inhabitants.

Puritanism. The Puritans were those who thought that the English Reformation had not gone far enough in its separation from the Roman Catholic Church, but that there were many ceremonies and forms still retained in the worship which were too suggestive of Papacy. They held that it was not expedient or right to retain the use of the cross in baptism, the clerical vestments, the custom of kneeling at the altar, and other forms which had been rejected by the Reformed Churches on the Continent. They believed that the worship should in this way be purified and that only those who lived upright lives should be the ministers of the church. To them the church was a means of advancing religious truth, and it could not do this to the best advantage while hampered, as they thought, by useless, misleading and unscriptural forms and ceremonies, especially when these forms and ceremonies were obligatory for all and the observance of them enforced by the civil authority. During the persecution of the Protestants in the reign of Mary, hundreds of the English reformers went to the Continent and were in the company of the leaders of the Reformed Church. When Elizabeth came to the throne, these men returned and became the leaders of English protestantism. Some of them regarded the wearing of the vestments prescribed by the Church authorities as a matter of indifference, others refused to wear them. They did not object to the government of the Church of England or the close connection between Church and State or the doctrinal system, but objected to what they regarded as the remnants of popery.

Whether they would be allowed to do as they wished or not depended largely on the attitude of the queen. Elizabeth was a woman whose religious tastes were stronger than her religious convictions and the simplicity and bareness of the worship of the Reformed Church offended her. She disliked Puritanism because the teachings of men like John Knox opposed her idea of the royal power. She opposed any puritanical modifications of the Prayer Book or of the ceremonies of the church. That there was to be no room for nonconformity was shown when her first parliament passed the Act of Uniformity, which made unlawful any form of public worship but that of the Prayer Book, and the

Act of Supremacy, by which the queen was acknowledged supreme governor of the realm in spiritual and ecclesiastical affairs. She resolved to retain in the worship as much show and form as possible, and ordered uniformity in vestments. If any refused they were forbidden to preach and deprived of their office. This law was not strictly enforced at first, but with greater rigor as the time went on. Large numbers were ejected from their churches, but continued to hold private meetings. Many were imprisoned and treated with severity. But nonconformity continued to grow notwithstanding the efforts to suppress it.

In early Puritanism the objection is mainly to the forms and ceremonies in the worship of the church. In the later years of the reign of Elizabeth, attention is given to the government of the Church and the relation between Church and State. Elizabeth claimed that in this her will was supreme. Some of the Puritans, above all others, Thomas Cartwright, taught that the only right form of Church government was that laid down in the New Testament and that it was Presbyterianism. He taught that the civil authorities are not to interfere in Church affairs, but they are bound to protect it. There is still to be a state church but with a Presbyterian rather than an Episcopal form of government. This was directly opposed to the Queen's supremacy, and her efforts to suppress this form of Puritanism were vigorous. These Puritan movements were within the Established Church, but there were some who believed that a church having any connection with the state was unscriptural and so there arose the party called Independents or Separatists. They taught that the local church was independent and should manage its own affairs. These were also called Brownists from Robert Browne, who was their first leader. The Separatists were severely persecuted and many left the country. Thus, at the close of the reign of Elizabeth, there are three kinds of Puritans: those who desire a purified worship and still remain in the Church, those who would have a state church under the Presbyterian form of government, and those who believed that an established church was wrong. Hopes were entertained that James VI., educated in Presbyterian Scotland, would be more favorable to Puritanism. The clergy petitioned him for freedom from the burden of human rites and ceremonies and the matter was considered at the Hampton Court Conference. But James' motto was "No bishop, no king," so they could look for little toleration. Uniformity was enforced with great vigor and many Puritans deprived of all hopes of redress left the country. This condition continued with even greater severity in the reign of his son, Charles I., and there seemed in the early part of his reign no check on his tyranny in church and state. Despairing of freedom in Old England, Puritan and Separatist turned to America to create there a New England. In 1620 a little company of Separatists after a sojourn in Holland came to America and settled at Plymouth. In the course of the next 20 years thousands of Puritans settle in Massachusetts. This Puritan emigration stops in 1640, when there seems a better prospect of liberty in England. The Puritan emigrants came as members of the Church of England with no desire to separate. The Pilgrims were already separated from the English communion and were independent in their church government. But the Puritans because of their distance from the home country and because of the influence of the Pilgrims very quickly adopted the Congregational or Independent form of church government.

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Pu'ritans. See PURITANISM.

Pur'kinge's Figures, in optics, figures produced on a wall of uniform color when a person entering a dark room with a candle moves it up and down approximately on a level with the eyes. From the eye near the candle an image of the retinal vessels will appear projected on the wall.

Purple of Cassius, a purple substance used to some extent in the arts, discovered by Dr. Cassius at Leyden in 1683. This substance is probably an oxide of gold containing small quantities of oxide of tin; it is prepared by adding protochloride of tin, along with a little perchloride, to a solution of chloride of gold, when it is thrown down in the form of a dark purple-colored precipitate. Purple of Cassius, mixed with borax and applied to the surface of china, imparts a beautiful rose-pink or rich purple color, according to the quantity employed.

Purple Color. The ancients attributed the discovery of purple to the Phœnicians. The story of its having been discovered by a dog biting a purple-fish, and thus staining his mouth, is well known. The purple-fish was found not only on the Phœnician coasts, but in all other parts of the Mediterranean, so that the use of it in dyeing came to be common with other nations. The modern discovery of purple colors from coal-tar makes an important epoch in the history of the dye. Painters in oil and water-colors produce various shades of purple by mixing certain red and blue pigments. For work in oil French ultramarine, often called French blue, is mixed with vermilion or some madder red (madder carmine is best), or one of these reds with cobalt blue if a pale purple is wanted. For permanent purples in water-colors the same blues are used; but one of the madder reds, not vermilion, should be mixed with them. A much richer purple than any of the above mixtures will give is produced by Prussian blue and one of the lakes from cochineal — namely, carmine or crimson lake — but it is not permanent. This purple, as well as that obtained by mixing Indian red with indigo, also fugitive, was much used by water-color painters in past years. Purple madder is the only simple purple pigment available for the artist which is durable, and it is unfortunately costly. All purples are changed to neutral and gray tints by the addition of any yellow pigment. For house-painting maroon lake with a little French blue gives a useful purple. See DYES.

Purple-faced Monkey. See LANGUR; WANDEROO.

Purple Falcon, Order of the. See ORDERS, ROYAL.

Purple Finch, a handsome American finch (*Carpodacus purpureus*) which in some one of its varieties is known throughout the United States and Canada. The male exhibits in spring a plumage beautifully tinged with rose red and crimson; and sings a brilliant melody. These birds nest in orchard trees and similar places, and lay greenish speckled eggs.

Purple Martin, one of the large, lustrous, blue-black swallows of the genus *Progne,* several species of which inhabit South and Central America, while one (*P. subis*) is a familiar visitor in summer to almost all parts of the United States. They originally nested in hollow trees, but in both North and South America have at once associated themselves with mankind as soon as civilization approached their habitat; and now everywhere make their nests about buildings or in garden bird-boxes. They are among the most useful as well as interesting of our insect-hunting birds.

Purple Scale. See SCALE INSECTS.

Purple Shell, a gastropod mollusk of the family *Muricidæ* and especially of one section of it of which the genus *Purpura* is typical. A great many species are found in all seas. The true purples form the subfamily *Purpurinæ.* The *Muricidæ* are carnivorous marine snails very destructive to other mollusks, barnacles, etc. Many of the tropical species of *Murex* and related genera are of large size and remarkable for the large spines borne upon the shells, but our representatives of the family are small and inconspicuous. (See DRILL.) Our true purple shell (*Purpura lapillus*) is found in great abundance on rocky coasts on both sides of the North Atlantic, but is infrequent in the United States south of Long Island Sound, where it is replaced to some extent by related species. The shell is very thick and solid, short oval with a low spire and a large aperture, the outer lip of which is marked with revolving ridges. It is extremely variable in size, shape, color, and markings. Like the drill it is carnivorous, but with us confines its attacks chiefly to the barnacles which encrust the rocks between tides, though in Europe it works great havoc on the mussel beds.

The name «purple shell» applied to this group of mollusks is derived from the use to which certain species were put by the ancients in the preparation of their most valued dye-stuffs, for which the city of Tyre was especially famous, and upon which its prosperity about 1000 B.C. was founded. The Tyrian purples were of several shades, varying from blue to a dull crimson, dependent upon the particular variety of shell employed and the substances mixed with the extract. Among the most important species utilized were *Murex trunculus, M. brandaris,* and *Purpurea patula.* These snails were gathered on both the African and European shores of the Mediterranean. The smaller ones were crushed in mortar-shaped holes in the rocks and mixed with soda, urine, sea-water, and other substances; the larger animals were removed from their shells or the dye squeezed out. The desired colors were obtained by exposure to the sun and by various combinations, and the cloth was steeped in a large excess of fluid until the proper effect had been produced. The fluid is contained in a saccular gland which opens into the mantle cavity and has at first the color and consistency of cream and a disagreeable odor, but changes to purple upon exposure to light. Consult Simmonds, ‹Commercial Products of the Sea.›

Pur'pura. See PURPLE-SHELL.

Purse, a specific sum of money, usually awarded as a prize in athletics, horse-racing, and other sports. In Turkey it consists of 500 Turkish piastres, and its value is $22; in Egypt a purse consists of 500 tariff piastres, value $25; in Persia, 50 tomans, value $107. See PRIZE.

Purser, a name applied to the cashier or chief clerk on board a passenger steamer. In the navy a purser was formerly an officer who took charge of the provisions of a ship of war, and saw to their distribution among the officers and crew. He had very little to do with money matters, but generally bore an evil reputation among the sailors for unfair dealing and rapacity. The designation is now discarded for that of paymaster, who holds a different position.

Purs'lane, a pot-herb and well-known weed forming good fodder for pigs and called «pussley» by farm-hands. See PORTULACA.

Pursuivant, pėr'swĭ-vạnt, a title used in the heraldry of England, Scotland, and Ireland, and derived from the Latin word «prosequi,» to follow. It is the lowest of heraldic offices, but from the pursuivants were usually selected the superior officials known as herald and king-at-arms. The English college of arms has four pursuivants, the Scottish heraldic establishment has three, and the Ulster king-at-arms in Ireland has four.

Puru-Purus, poo-roo'-poo-roos', or **Puru Pulas,** a tribe of Brazilian Indians, now extinct or represented only by the Pamary or Paumary, but formerly living along the Purus River (q.v.) in western Brazil. They were naked savages, who slept on the sand instead of in hammocks, and were afflicted by a leprous disease which covered them with bluish and whitish spots. They used practically no sheltering or covering, except leaf umbrellas, and wore their hair long and unkempt, cut only on the forehead in a square bang. Linguistically they seem to have been separate from the surrounding peoples.

Puruandiro, poo-roo-ăn-dē'rō, Mexico, a town of the state of Michoacán and capital city of the district of Puruandiro in central Mexico, situated on the southern shore of a small lake, about 42 miles northwest of Morelia. It does a small business in Mexican leather and in the agricultural produce of the surrounding country.

Purus, poo-roos', a South American river, an affluent of the Amazon, rising in the east of Peru traversing the northwest corner of Bolivia, entering Brazil, and after a northeastward course of over 1,800 miles, joining the Amazon about 100 miles above the latter's confluence with the Madeira. It has a very winding course and a comparatively slight fall. In the flood season it is navigable almost throughout its length. Chief among its numerous tributaries is the Acre. Its source was discovered in 1864 by Chandless, an English explorer.

Purver, pėr'vėr, **Anthony,** English translator: b. Hurstbourne, Hampshire, 1702; d. Andover, Hampshire, July 1777. He was at first apprenticed to a shoemaker, but mastered Hebrew, and at 20 opened a school. Later he went to London where he became a Quaker and there began his translation of the Bible in 1733, a task which occupied him for 20 years. It was completed in 1763 and published under the title ‘A New and Literal Translation of all the Books of the Old and New Testament’ (1764). The publication was known as the ‘Quaker's Bible’ and by many was pronounced crude and unscholarly, while warmly approved by Southey and other critics. He also published: ‘Youth's Delight’ (1727); ‘Poem to the Praise of God’ (1748); and ‘Counsel to the Friend's Children’ (1785).

Purves, pėr'vĕs, **George Tybout,** American clergyman: b. Philadelphia, Pa., 27 Sept. 1852; d. New York 24 Sept. 1901. He was graduated from the University of Pennsylvania in 1872 and from the Princeton Theological Seminary in 1876. He was pastor at Wayne, Pa., 1877–80; and professor of New Testament literature and exegesis at Princeton Theological Seminary 1892–1900. In the last named year he accepted a call to the 5th Avenue Presbyterian Church, New York. He wrote: ‘The Testimony of Justin Martyr to Early Christianity’; ‘The Apostolic Age’; etc.

Purvey, pėr'vĭ, **John,** English Biblical translator: b. Lathbury, Buckinghamshire, about 1354; d. about 1427. While associated with Wyclif, whose disciple he became, he undertook with other scholars the revision of the translation of the Bible made by Wyclif in 1380. The revision was substantially a new work merely based on Wyclif's copy which had retained many Latinisms from the Vulgate. The new translation, on the other hand, was made in good idiomatic English. It was completed about 1388, four years after Wyclif's death. For his Wycliffite views he was imprisoned in 1390, recanted to escape martyrdom in 1401, and for two years was vicar of West Hythe, Kent. Purvey wrote against the corruption of the Church, a work entitled ‘Ecclesiæ Regimen.’ Consult: Lechler, ‘John Wiclif and his English Precursors,’ translated by Lorimer (1884).

Pus. See SUPPURATION.

Pusey, pū'zĭ, **Caleb,** American Quaker colonist: b. Berkshire, England, about 1650; d. Chester County, Pa., 25 Feb. 1727. He was educated a Baptist, but joined the Quakers and came with Penn's company to America in 1682, erected the first mills in the province known as the «Chester Mills,» and of which Penn himself laid the cornerstone. He laid out roads, treated with the Indians, was sheriff of Chester County for two years, justice of the peace and of the county courts for many years, an associate justice of the supreme court, and for 10 years member of assembly. He published a great number of pamphlets and articles in defense of his creed, among them: ‘A Serious and Seasonable Warning’ (1675); ‘A Modest Account from Pennsylvania of the Principal Differences in Point of Doctrine between George Keith and those of the People called Quakers’ (1696); ‘Satan's Harbingers Encountered’ (1700); etc.

Pusey, Edward Bouverie, English scholar and theologian: b. near Oxford 22 Aug. 1800; d. Ascot Priory, Berkshire, 16 Sept. 1882. He was a son of the Hon. Philip Bouverie (of the Radnor family), who assumed the name of Pusey by royal license on becoming lord of the manor of that name in Berkshire. He was educated at Eton and Oxford University, where he was graduated with first class honors. Soon after he was elected to a fellowship at Oriel College. He studied for two years in Germany, taking up more especially Oriental languages, theology, and German, and in 1828 was appointed regius professor of Hebrew, a post which he retained all his life, and to which a canonry at Christ Church is attached. In 1826 he had published a book summarizing the progress of German theological thought since the Reformation, expounding the rationalistic views regarding religion which were common in Germany, his account of which was founded on his own personal experience of what he believed to be the evils of Rationalism. He became through the influence of his friends Hurrel, Froude, and Newman an ally of the theological party who started the Tracts for the Times (see TRACTARIANISM), but the agitation had been going on a little time before he took an active part in it. His first tract was the 18th, ‘On the Benefit of Fasting’; he subsequently wrote another (the 66th) on the same subject, and two (the 67th, and 69th) ‘On Holy Baptism.’ In connection with the same High Church movement he undertook the joint-editorship of the ‘Library of the Fathers’ and the ‘Library of Anglo-Catholic Theology.’ In 1843 he was suspended from preaching in the university pulpit for three years on account of a sermon on the Eucharist, in which he advocated the doctrines of the real presence, sacerdotal absolution, and of the duty and privilege of confession. Except for literary labors and occasional sermons, Dr. Pusey's life was henceforward an uneventful one. Among his chief works are a treatise on ‘The Ancient Doctrine of the Real Presence’; ‘Letters to the Archbishop of Canterbury in Defence of Church Principles’; a treatise on ‘Marriage with a Deceased Wife's Sister’; a ‘History of the Councils of the Church’ (1857); a learned ‘Commentary on the Minor Prophets’ (1860–77), an important contribution to Hebrew scholarship. Nine lectures on ‘Daniel the Prophet’ (1864), and ‘The Church of England, or Portion of Christ's Holy Catholic Church: an Eirenicon’ (1865). As a leader of the Tractarian or High Church party he kept a large section of that party from drifting into the Catholic Church and remained unshaken in his fidelity to the church of his baptism, while Oakley, Ward, Wingfield, Newman, and more than 100 other English clergymen went over to Rome. On this ground, perhaps, the party received the popular name of Puseyites. Pusey was one of the few Oxford professors whose linguistic accomplishment laid open to him the latest researches and discoveries of German scholarship. He was very retired in his habits, but kindhearted, and his charity was unbounded. Pusey House, one of the most recent of Oxford colleges, was founded as a memorial to him, and was intended to continue the tradition of his teaching which it has done to the same extent as All Souls has fulfilled the purpose of offering masses for the repose of the souls of those who perished in the Hundred Years' war. Consult: Liddon, ‘Life of Edward Bouverie Pusey’ (1893–7); Grafton, ‘Pusey and the Church Revival’ (1902).

Puseyism. See Oxford Movement, The.

Pushkin, poosh'kĭn, **Alexander** (spelled also Poushkin, Pouchakin), Russian poet: b. Moscow 26 May (7 June) 1799; d. Saint Petersburg 29 Jan. (10 Feb.) 1837. He received his first education in the Lyceum at Tsarskoë-Selo. In 1817 he entered the service of the government in the ministry of foreign affairs, in 1820 was retired to southern Russia because of his liberal opinions, until 1824 was a subordinate in the office of the governor-general of Odessa, angered his superior by an epigram, and was withdrawn wholly from the service and ordered to live on his estate of Mikhailovskoë. In 1826 Nicholas I. allowed his return to Saint Petersburg, where he was made imperial historiographer. His only work of research, however, was the ‘History of the Revolt of Pugachev’; he labored in the archives on an account of Peter the Great, which came to nothing. He died from a wound received in a duel, and the Czar appropriated 150,000 rubles to settle his affairs and publish his works. These included, above all, ‘Evgenie Onyegin’ (1828), a metrical narrative in a somewhat Byronesque fashion; and ‘Boris Godunov,’ a tragedy dealing with the troublous period following the death of Czar Feodor. Pushkin performed a great service for the Russian language and literature; molding the former, which, prior to his time was uncouth and unwieldy, and freeing the latter from its French tradition and placing it solidly upon a native basis. He has been called «undeniably and essentially the great national poet of Russia.» There are English renderings of ‘Evgenie Onyegin’ (by Spalding, 1881); of the ‘Poems’ (by Panin, 2d ed. 1888); and of the ‘Prose Tales’ (by Keane, 1896). A memorial work, ‘Translations from Pushkin,’ by Turner, appeared in 1899. Consult: Shaw, ‘Sketch of Pushkin's Life and Works’ (1845); Flach, ‘Un Grand Poète Russe’ (1894).

Puss in Boots, a well-known nursery tale by Charles Perrault, whose version, ‘Le chat botté’ appeared in his ‘Contes de Fées’ (1697). It was probably taken from Straparola's ‘Piacevoli Notti.’ The story is found in a Norse version in ‘Lord Peter,’ and in the Swedish ‘Palace with Pillars of Gold,’ in which the cat befriends a girl, whose adventures are similar to those of the Marquis of Carabas. In a Sicilian version is found the first hint of a moral which is lacking in the above-mentioned tales; that is, the ingratitude of the man. Cosguin imagined from the moral that its origin was Buddhistic, for the story could only have arisen in a comparatively civilized community; but the only Hindu version, the ‘Match-Making Jackal,’ discovered about 1884 in Bengal, has no moral at all. The most complete moral is found in Zanzibar, in the Swahili tale of ‘Sultan Darai,’ in which the beneficent beast is a gazelle: the ingratitude of the man is punished by the loss of all that he had gained; the gazelle, which dies of neglect, is honored by a public funeral. A well-known German version is that by Tieck, ‘Der gestiefelt Kater’ (1795).

Pus'tules. See Pimples.

Put Yourself in His Place, a novel by Charles Reade, published in 1870. The scene is laid in an English manufacturing town, and the story narrates the struggles of Henry Little, workman and inventor, against the jealousy and prejudice of the trades-unions. Like all of Reade's stories, ‘Put Yourself in His Place’ has a wealth of dramatic incident, and moves with dash and vigor.

Putchock, pŭ-chŏk', or **Puchuck,** the root of *Aplotaxis lappa*, the «costus» of the ancients, a composite plant growing on the Himalayas in the vicinity of Cashmere. It has long lyrate leaves and heads of purple florets. It is exported to the Malay countries and to China, where it forms a main ingredient in the Chinese pastille-rods known as joss-sticks. In Upper India it is given as a medicine in various complaints ranging from coughs to cholera, and is also employed in several other ways.

Putlitz, poot'lĭts, **Gustav Heinrich Gans,** Edler Herr von und zu, German novelist and poet: b. Retzin, Prussia, 20 March 1821; d. there 9 Sept. 1890. He was educated at Magdeburg, Berlin, and Heidelberg, was engaged in the civil service in 1846–8 and made his début in literary circles by his comedies which aptly portrayed high social life and excelled in humor. In 1863 he was appointed director of the court theatre at Schwerin, and his collected dramas were published in 1850–69. His poems were characterized by much beauty and grace and his charming fairy poem ‘Was sich der Wald erzählt’ (1850) was widely circulated. His novels were also popular. Among his publications are: ‘Vergissmeinnicht’ (1851); ‘Brandenburger Geschichten’ (1862); ‘Novellen’ (1863); ‘Funken unter der Asche’ (1871).

Putnam, pŭt'nam, **Frederick Ward,** American archæologist and ethnologist: b. Salem, Mass., 16 April 1839. He became curator at Essex Institute in Salem in 1856, was graduated from Harvard in 1862, and in 1864 became director of the Essex Institute museum. In 1867 he was appointed superintendent of the East Indian Marine Society's museum at Salem and in 1875 was appointed civilian assistant on the United States surveys west of the 100th meridian, his duties being to make investigations and reports of the archæological and ethnological material collected. In 1876–8 he was in charge of the Agassiz collection of fishes at the Museum of Comparative Zoology and in 1886 was appointed professor of American archæology and ethnology at Harvard. He was chief of the department of ethnology at the World's Columbian Exposition in 1893. He is author of numerous pamphlets on scientific subjects, was one of the founders and editors of the ‘American Naturalist,’ and has edited many volumes of ‘Annual Reports of the Trustees of the Peabody Museum of Archæology and Ethnology’ and ‘Proceedings of the Essex Institute.’

Putnam, George Haven, American publisher and author, son of G. P. Putnam (q.v.): b. London, England, 2 April 1844. He was educated in New York, Paris, and Göttingen, leaving the university at the latter place to enter the Union army as a volunteer in 1862. He served through the war, was a prisoner at Libby in the winter of 1864–5, and attained rank as major of volunteers. He is head of the firm

G. P. Putnam's Sons, was a leader in reorganizing the American Copyright League in 1887, and was instrumental in securing the passage of the copyright bill in 1891. He has published: 'Authors and Publishers' (1883); 'The Artificial Mother' (1894); 'Books and their Makers in the Middle Ages' (1896); etc.

Putnam, George Palmer, American publisher and author: b. Brunswick, Maine, 7 Feb. 1814; d. New York 20 Dec. 1872. He entered the book store of Jonathan Leavitt in New York in 1828, became a member in the firm Wiley and Putnam in 1840 and in 1841 went to London where he conducted a branch business. In 1848 he returned to New York, opened a publishing house, engaged in the production of finely illustrated books and established 'Putnam's Magazine' 1853–6, which was resumed in 1868 and afterward merged with 'Scribner's Monthly.' In 1866 he established the publishing firm now known as G. P. Putnam's Sons. He was an ardent advocate of international copyright reform, secretary for many years of the Publishers' Association, a founder of the Metropolitan Museum of Art, and wrote: 'A Plea for International Copyright' (1837); 'Chronology' (1833); 'The Tourist in Europe' (1838); 'American Facts' (1845); 'The World's Progress' (1850); 'Ten Years of the World's Progress' (1861); etc.

Putnam, Herbert, American librarian: b. New York 20 Sept. 1861. He was graduated from Harvard in 1883, studied law at Columbia and in 1886 was admitted to the bar. He was librarian at the Minneapolis Athenæum in 1884–7 and of the Minneapolis Public Library 1887–91; practised law in Boston in 1892–5, was librarian of the Boston Public Library in 1895–9 and in the latter year was appointed librarian of Congress. He became president of the American Library Association in 1898 and one of the overseers of Harvard in 1902.

Putnam, Israel, American Revolutionary soldier: b. Salem (now Danvers), Mass., 7 Jan. 1718; d. Pomfret (now Brooklyn), Conn., 19 May 1790. His education was a desultory one. In 1740 he removed from Salem, and purchased in that part of Pomfret, Conn., which is now Brooklyn, the farm where he afterward resided. It is said that he also hung out a shingle advertising entertainment for man and beast. There is also the well-known anecdote of the exploit in which he crept into the lair of a destructive wolf, and there despatched the animal. But little definite is known of Putnam's life until he is found in 1755 in receipt of a commission as captain of Connecticut volunteers in a regiment sent by the colony to aid in repelling a threatened French invasion of New York. He was present at the defeat of the French and Indians under Dieskau near the southern end of Lake George, and later was very successfully employed as a ranger and scout. In 1756 he commanded a company in Abercrombie's army, which had Crown Point as an objective, but was so outplayed by Montcalm as to be obliged to act rather defensively than offensively. He received a major's commission from the Connecticut legislature in 1757. During Abercrombie's expedition against Ticonderoga in 1758, Putnam commanded an advance guard and scouting party of 100. In the retreat following the rash and disastrous attack on the post, he became aide to Abercrombie, replacing Howe, who had been shot. Having been sent out in August to recapture from the enemy a large quantity of British stores, he was taken prisoner and tortured by the Indians, but rescued by a French officer. He was sent to Ticonderoga and thence to Montreal, where he was exchanged. Promoted lieutenant-colonel in 1759, he accompanied the force sent against Montreal, upon whose surrender Canada passed into English hands. In 1762 he commanded the contingent of 1,000 sent by Connecticut in the naval expedition against Havana. His vessel was wrecked off the Cuban coast, but those on board escaped by rafts, and took part in the successful attack on Havana. He was sent out against the Indians of the frontier, who, under Pontiac (q.v.), were menacing Detroit, in 1763. A peace was concluded; Putnam returned to his farm, and there remained in retirement until 1775. When the news of Lexington reached him, he is said to have been plowing, Cincinnatus-like; and at once to have turned loose the oxen and ridden to Cambridge. A Connecticut regiment was forthwith organized, and Putnam, with a brigadier's commission, appointed to command it. In May he led a battalion to Noddle's Island, where he captured a sloop and burned a schooner of the enemy. He was a participant in the battle at Breed's (Bunker) Hill, which he had helped to fortify; the chief command in the action has been claimed for him against Prescott. Trumbull, in his picture in the Capitol at Washington, shows Putnam in brilliant uniform defending a gun. Commissioned major-general in July, he was placed in command at New York, and was ranking officer within the fortifications during the battle of Long Island. After having been stationed at Philadelphia, Crosswick, and Princeton, he was sent in May 1777 to command in the «Highlands» of New York. Owing to the loss of Fort Montgomery and Fort Clinton, he was removed from his command; but later was restored on being acquitted by a court of inquiry. Subsequently, when he was commanding in Connecticut, Horseneck, an American outpost, was attacked by the British under Tryon. Putnam, according to the story, escaped by dashing on horseback down-hill, and eventually pursued the retreating Tryon, from whom he took 50 prisoners. In the winter of 1779 he was stricken with paralysis and incapacitated from further service. Consult 'Lives,' by Tarbox (1876) and Livingston (1901).

Putnam, John Pickering, American architect: b. Boston, Mass., 1847. He was graduated from Harvard in 1868, studied later in the Ecole des Beaux Arts, Paris, and in the Royal Academy of Architecture, Berlin. He has since practised his profession in Boston and has published: 'The Open Fire Place in All Ages'; 'The Principles of House Drainage'; 'Improved Plumbing Appliances'; 'The Outlook for the Artisan and His Art.'

Putnam, Mary Traill Spence Lowell, American author, sister of James Russell Lowell (q.v.): b. Boston, Mass., 3 Dec. 1810; d. there 1 June 1898. She was married to Samuel R. Putnam in 1832, and later traveled abroad for several years. Her literary work was confined to magazine writing until 1844, when she translated from the Swedish Fredrika Bremer's 'The Handmaid.' She afterward published: 'History of the Constitution of Hungary' (1850); 'Records of an Obscure Man' (1861); 'The Tragedy of Errors' and 'The Tragedy of Success,' a dramatic poem in two parts (1862); 'Fifteen Days' (1866); 'Memoir of Charles Lowell' (1885); etc.

Putnam, Rufus, American Revolutionary soldier: b. Sutton, Mass., 9 April 1738; d. Marietta, Ohio, 1 May 1824. He was apprenticed in 1754 to a millwright, but acquired some knowledge of surveying and later found employment in that profession. In March 1757 he enlisted as a private for service in the French and Indian war; and re-enlisted yearly until 1761, being made ensign in 1760. His story of the campaigns in which he served may be read in the 'Journal' which he kept throughout. He was a farmer successively at New Braintree, Mass. (1761), Brookfield, Mass. (1765), and Rutland, Mass. (1780). In 1773 he went to Florida as one of an investigating committee appointed to examine lands granted by the crown to colonial soldiers and officers who had fought in provincial regiments during the French and Indian war. Putnam was made deputy-surveyor of Florida by the governor of the province, and accompanied the expedition up the Mississippi to the Yazoo, up the Yazoo to Haines' Bluff, back to the Big Black, and thence in return down the Mississippi. He planned and directed the construction of the Continental lines of defense at Roxbury, and for the excellence of his work was detailed by Washington as acting chief-engineer of the army. On 11 Aug. 1776 he was appointed by Congress chief engineer of the army, with colonel's rank; but preferring service in the field, he resigned in December and took command of the 5th Massachusetts regiment. With the northern army in 1777 he did conspicuous service, particularly at Stillwater, where he headed the 4th and 5th regiments of Nixon's brigade. On 7 Jan. 1783 he was promoted brigadier-general. He was for several years a member of the Massachusetts legislature, and during Shays' rebellion (q.v.) (1786–7) was a very efficient aide on the staff of Gen. Benjamin Lincoln. In March 1787 he was chosen (with Gen. S. H. Parsons and Rev. Manasseh Cutler) a director of the Ohio company, organized (1 March 1786) with a capital of $1,000,000 in public securities, to be expended in the purchase of land in the Northwest Territory. In July a contract was made with Congress for one and a half million of acres, and soon afterward an ordinance, familiarly known as the "Ordinance of 1787," was passed providing for the government of the territory. On 7 April 1788 Putnam, meanwhile made superintendent of the company, landed with a party of emigrants at the mouth of the Muskingum, and on the present site of Marietta commenced the first organized settlement in the Northwest Territory. He concluded in 1792 at Vincennes a treaty with eight tribes of the Wabash Indians, and in 1793 resigned his commission in the army. He was one of the judges of the United States court in the Territory, 1790–6, and from 1796 until his removal by Jefferson for political reasons in 1803 was surveyor-general of the United States. He was the founder of the first Bible society west of the Alleghanies (1812), a sturdy Federalist in politics, and with the exception of Lafayette the last survivor of the general officers of the Continental army. Consult his 'Journal,' edited, with sketch, by Dawes (1886). Putnam's papers, including the manuscript 'Journal' and correspondence with Fisher Ames, Trumbull, Washington, and others are preserved at Marietta in the library of the college there; they were edited by Rowena Buell (1904) under the title 'The Memoirs of Rufus Putnam and Certain Official Papers and Correspondence.'

Putnam, Sarah A. Brock, American writer: b. Madison Court House, Va., about 1845. In 1883 she was married to the Rev. Richard Putnam, an Episcopal clergyman. She has published: 'Richmond during the War' (1867); 'The Southern Amaranth' (1869); 'Kenneth, My King' (1872); 'Myra,' a novel.

Putnam, William Le Baron, American jurist: b. Bath, Maine, 12 May 1835. He was graduated from Bowdoin College in 1855, admitted to the bar in 1858 and engaged in law practice in Portland, Maine, 1858–92. In 1887 he accepted an appointment by President Cleveland as commissioner to settle with Great Britain the rights of American fishermen in Canadian waters, and was also a member of the commission under the treaty of 6 Feb. 1896 between Great Britain and the United States. He had twice declined appointments as justice of the Maine supreme judicial court, but in 1892 accepted an appointment as judge of the United States Circuit Court. In 1888 he was the Democratic candidate for the governorship of his State.

Putnam, Conn., city, one of the county-seats of Windham County; on the Quinebaug River, and on the Norwich & W. and the New York, N. H. & H. R.R.'s; about 45 miles east by north of Hartford. It was incorporated from portions of the towns of Thompson, Killingly, and Pomfret, by the State Assembly in May 1855, and was organized as a municipality 3 July 1855 and in 1895 was chartered as a city. Nearby are Cargill Falls, noted for their beauty. It is in an agricultural region, but it has a number of manufacturing interests. The chief industrial establishments are cotton and woolen mills, boot and shoe factories, silk mills, and manufactories of heaters and castings. The number of employees in the manufactories is about 1,900. It has the Day Kimball Hospital, Saint Mary's Convent, and seven churches. The educational institutions are Notre Dame Academy, a high school, public and parish schools, and a public library. There are two banks, one National, with a capital of $150,000, and one savings, and the business annually is over $20,000,000. The government is administrated under the charter of 1895 which provides for a mayor, who holds office two years, and a council of nine members. Pop. (1910) 7,280.

Putnam, Fort, a former Revolutionary fort at West Point, N. Y.

Puts and Calls. See STOCK EXCHANGE.

Puttenham, pŭt'ĕn-am, **George,** English author: b. about 1530; d. about 1600. He is reputed to be the writer of a work entitled 'The Arte of English Poesie, contrived into three bookes; the first of Poets and Poesie, the second of Proportion, the third of Ornament,' which appeared anonymously in 1589. The Arte is a review of ancient as well as modern poetry, and was written for the court. It shows considin 1792. Pye was a voluminous writer, contributed to the literature of the stage and translated Aristotle's ‹Poetics.› He seems, however, not to have set great store on his poetry himself, and observed that he had rather be thought a good Englishman than the best poet or the greatest scholar that ever wrote.

Pye, John, English engraver: b. Birmingham 22 April 1782; d. London 6 Feb. 1874. In 1802 he went to London and came under the influence of John Heath. Success in rendering landscape brought him to the attention of Turner, who engaged him to engrave a plate from his ‹Temple of Jupiter at Ægina.› A long Turner series of engravings followed. Being a Turner enthusiast he collected one of the finest sets of plates engraved after that master. He published ‹Patronage of British Art› (1845), and began the publication of ‹Pictures from the National Gallery,› terminated after 29 parts were issued.

Pygmalion, pĭg-mā'lĭ-ŏn, (1) in Greek legend a son of Clix and grandson of Agenor, king of Cyprus. In the story told by Ovid (Met. x. 243) he conceived an aversion to women and devoted himself to art, but having made an ivory statue he became so enamored of it that he entreated Aphrodite to endow it with life. This was done; the statue became a beautiful woman whom Pygmalion married and by whom he had Paphos, founder of the city of that name in Cyprus. W. S. Gilbert's play, ‹Pygmalion and Galatea,› is founded on this story. (2) Tyrian king and brother of Dido. He murdered Dido's husband Acerbas or Sichæus upon which Dido took her dead husband's treasures and sailed for the coast of Africa where she founded Carthage.

Pyg'mies, the name given by the ancients to a race of dwarfish men reported as existing in various parts of the world. Homer (Il. iii. 6) fixes the habitat of the pygmies in the far southland whither the cranes migrate at the approach of winter; after Homer the battles of the cranes and the pygmies are a favorite theme of poets, and are often pictured on vases. Ancient authors, whether travelers, historians, or miscellanists, like Herodotus, Ctesias or Pliny, describe the pygmæi as little men, the tallest of them not exceeding in height two *pygmæ* (Gr. *pygme,* a measure of length, the distance from the elbow to the knuckles — less than 14 inches). Herodotus locates his pygmæi in the heart of Africa in a region traversed by a great stream — probably the Niger — flowing from west to east, and modern geographical research gives support to his story after it had long passed for fabulous. In recent times the actual existence of pygmies has been ascertained beyond any question, though when Paul B. Du Chaillu (q.v.) in 1861 published his ‹Explorations and Adventures in Equatorial Africa› his description of the pygmy tribes discovered by him was scouted by scientific men as mere fiction. But when his report was confirmed in every essential particular by the missionary Father des Avanchers (1869), by Schweinfurth (1871), by Stanley (1876) and others, scientific skepticism gave way, grudgingly, to conviction of Du Chaillu's good faith. Many different tribes of pygmies are now recognized as existing in the interior of Africa, all possessing these characteristics: stature ranging from 33 inches to 4 feet 4 inches, as reported of the Wambutti by Stanley: Schlichter makes the average stature 4 feet 6 inches; complexion, from yellowish brown to reddish brown; usually heavy growth of hair on body and face — a curious item of accordance with the report of Ctesias regarding the pygmæi of India, who had «beards and hair so long as to serve for vesture»; retreating forehead, prognathic jaw; fingers long, tapering, and feet strongly arched; in their villages the huts (8 feet long, 5 feet wide, 4 feet high) are clustered round the hut of the chief; their usual food is vegetable, but they eat almost anything: in hunting they show great intelligence; one tribe, the Wambutti, devise exceedingly ingenious nets, nooses and traps for securing game great and small.

Pylades, pĭ'la-dēz, a legendary Greek hero, celebrated for the friendship which existed between him and Orestes. He assisted Orestes in murdering his mother Clytæmnestra, and eventually married Electra, the sister of his friend. See ORESTES.

Pyle, pīl, **Howard,** American artist and author: b. Wilmington, Del., 5 March 1853. He combines literary and artistic talent and in this double capacity began his career in New York city by contributing to various periodicals. Having achieved a position he returned to his native place where he has resided since 1879. He has been instructor at the Drexel Institute, Philadelphia, but his time is largely occupied with original productions for current periodicals. In art he especially affects scenes of colonial life and of mediæval folk-lore and is remarkably successful in conveying their spirit. Some of the finest achievements in color printing in the magazines of recent times have been from his drawings. Works of which he is both author and illustrator are ‹The Merry Adventures of Robin Hood› (1883); ‹Pepper and Salt, or Seasoning for Young Folks› (1885); ‹Within the Capes› (1885); ‹The Wonder Clock› (1887); ‹The Rose of Paradise› (1887); ‹Otto of the Silver Hand› (1888); ‹A Modern Aladdin› (1891); ‹Jack Ballister's Fortunes› (1894); ‹Twilight Land› (1895); ‹Semper Idem› (1903). He also wrote ‹Rejected of Men› (1903), the story of the Christ in modern setting.

Pylos, pī'lŏs, or **Pylus,** three ancient Greek cities. (1) Pylos in Elis, on the Peneus and Ladon, was an outpost of the Eleans. (2) Pylos in Triphylia, modern Biskini, east of Mount Minthus, was reckoned Nestor's city by Strabo; but this honor is now generally bestowed on (3) Pylos, a city on the western coast of Messenia, on the present gulf of Navarino. If this identification be accepted, Pylos must have been a flourishing city in Homeric times. It resisted Sparta after the second Messenian war, and upon the fall of Ira the inhabitants deserted the city and settled mostly in Sicily. The Athenian general Demosthenes seized the ruined city early in the Peloponnesian war, 424, intending to make it the rallying point for the Messenian disaffection against Sparta. He got a strong position on the eminence called Coryphasium, but was hemmed in on land and sea by the Spartans, who made Sphacteria their base. Demosthenes beat them back by land, the Athenians defeated the Spartan fleet and the Athenians perfected the blockade of the island of Sphacteria. Demosthenes, reinforced by Cleon, who took all the glory, burned the woods on the island and forced the Spartans to surrender. (See PELOPONNESIAN WAR.) The city was rebuilt by Epaminondas, who attempted to raise up a new Messenian nation. The present name is Navarino, either because of an Avar colony (so originally Avarino) or because of a Navarrese settlement in 1381. See NAVARINO.

Pym, pĭm, **John**, English statesman: b. Brymor, Somersetshire, 1584; d. London 8 Dec. 1643. He was educated at Oxford, and in 1602 entered the Middle Temple, but was never called to the bar. He became member of Parliament for Calne in 1621, but from 1625 sat for Tavistock. He was prominent in the impeachment of the Duke of Buckingham in 1616, and in 1639, with several others, held close correspondence with the commissioners sent to London by the Scottish Covenanters. When Parliament met again in 1640, Pym was one of its most active and leading members, and in the Long Parliament, which met later that same year, he came most prominently to the front. Possessed of great eloquence, he made a vigorous and effective speech as soon as Parliament had opened, dwelling at length upon the grievances of the nation with respect to parliamentary privileges and civil and religious liberty. A few days after he followed up his speech by bringing a charge of high treason against the Earl of Strafford, prime minister of Charles I.; and in the impeachment which followed, resulting in the death of Strafford, he took the leading part. In 1641 a motion was carried by the opposition party to submit a remonstrance to the king exposing the defects of his administration since ascending the throne, and the zeal of Pym in this matter led Charles into the imprudent measure of going to the Parliament in person to seize him and four other members. Clarendon relates that Charles I., feeling the necessity of gaining at any cost an enemy at once so implacable and so skilful, offered to Pym the post of chancellor of the exchequer. In November 1643, he was appointed lieutenant of the ordnance, but died the following December. He was buried with great pomp in Westminster Abbey. Consult: Forster, 'Statesmen of the Commonwealth' (1841-4); 'The Arrest of the Five Members' (1860); and 'The Debates on the Grand Remonstrance' (1860); Goldwin Smith, 'Three English Statesmen' (1867); S. R. Gardiner, 'The Great Civil War' (1893).

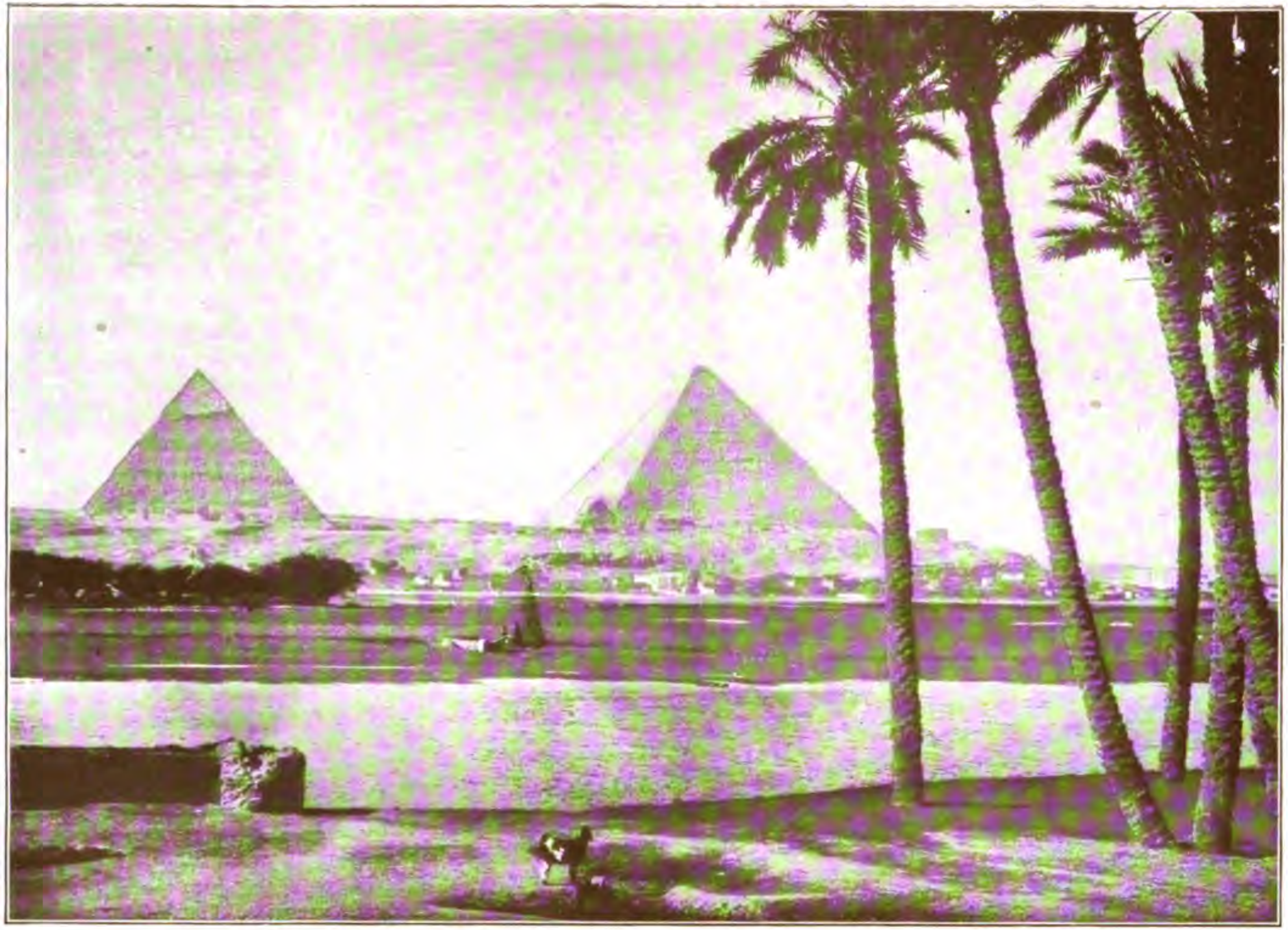
Pynchon, Thomas Ruggles, American Protestant Episcopal clergyman and physicist: b. New Haven, Conn., 14 Jan. 1823. He was graduated from Trinity College in 1841, was lecturer on chemistry there 1843-7, studied for the ministry, and was ordained priest in 1849. In 1849-55 he was in charge of parishes in Stockbridge and Lenox, Mass., and in 1854 accepted the chair of chemistry and natural science at Trinity College which he held until 1877 when he exchanged for the chair of moral philosophy. He was president of the college 1874-83. In 1874-8 he superintended the erection of the college buildings on the west side of the quadrangle and the transfer of the college to the new site. While in Europe 1855-6 he made a tour through southern France, Italy, and Sicily, engaged in geological investigations, made a study of volcanic action, and ascended Mount Ætna at night. In 1902 he became professor emeritus at Trinity. He is a member of the American Academy of Arts and Sciences, was one of the founders of the Meteorological Society, of which he is vice-president, and is connected with various other scientific societies both American and foreign. He has published: 'Treatise on Chemical Physics' (1869); 'An Examination of Bishop Butler's Analogy' (1890).

Pynchon, William, American colonist and religious writer: b. Springfield, Essex, England, 1590; d. Wraysbury, England, 29 Oct. 1662. He was a man of education, one of the grantees of the Massachusetts charter and came to America with Governor John Winthrop in 1630. He held various offices in the colony, from 1632 to 1634 acting as treasurer. He first settled at Roxbury as one of the founders of the village and organizers of the church, but withdrew in 1736 with the company led by Rev. Thomas Hooker and Rev. Samuel Stone southward into Connecticut. Pynchon with his family and a small party settled at the junction of the Agawam and Connecticut rivers and founded the present town of Springfield. For several years this place was included in the Connecticut colony and Pynchon sat in its legislature, but in 1641, under Pynchon's influence, the Massachusetts court assumed jurisdiction. In 1650, during a visit to England, Pynchon published a book entitled 'The Meritorious Price of our Redemption.' In this the author took an anti-Calvinistic view of the atonement and so stirred up the colonists that the book was ordered to be burnt and the author cited to appear before the general court. His letter of explanation was deemed unsatisfactory and after being summoned a second time he left the colony in September 1652 and returned to England. He passed the remainder of his life at Wraysbury, near Windsor. His earlier book was republished with a rejoinder to the Rev. J. Norton, as 'The Meritorious Price of Man's Redemption' (1655). He also wrote 'Jews Synagogue' (1652); 'How the first Sabbath was ordained' (1654); 'Covenant of Nature made with Adam' (1662). Consult: Green, 'Springfield, 1636-1886: History of Town and City' (1888).

Pypin, Alexander Nicolaevitch, Russian scholar, historian and author: b. at Saratov in 1833; d. Saint Petersburg 9 Dec. 1904. Received his academic education at the University of Saint Petersburg, where he was appointed to a professorship in 1860, resigning two years later to enter the literary field. He contributed largely to the Sovremennik («Contemporary»), 1865-7, and from then until his death to the Vestrik Evropy («European Messenger»). His first work, a comparative study of Russian, Byzantine and Roman folk-lore, was published in 1859, followed by a 'History of Slavonic Literatures' (1865), 'The Intellectual Movements in the First Half of the 19th Century,' and a masterly biography in two volumes of Byelinski, the critic, in 1876. A four-volume work, 'The History of Russian Ethnography,' was published in 1892-4, and the 'History of Russian Literature' in 1898-9. In 1897 he was appointed a member of The Academy of Sciences of Saint Petersburg, publishing for them the works of Catharine II.

Pyral'idæ, a family of moths (q.v.).

Pyr'amid, in architecture, a structure of masonry generally having a rectangular base and four triangular sides terminating in a point. According to Herodotus the Egyptians considered the pyramidal form as an emblem of human life; the broad base was significant of the beginning, and its termination in a point of the end of our existence in the present state; for which reason they made use of this figure in their sepulchres. The most remarkable pyramids are those of Egypt and Nubia and those of Mexico. The Egyptian pyramids have for ages been a source of interest and curiosity, and in ancient times were regarded as forming one of the seven wonders of the world. They are built mainly of a hard limestone, but large blocks of granite are also used, especially on the outside. The four sides are so placed as to face the four cardinal points. Being intended both as monuments and as tombs, they contain one or more sepulchral chambers, quite small compared with the total mass. They appear to date from the period of the 3d dynasty to the 12th (say 2500–2000 B.C.), after which none were built. Each pyramid was commenced over a sepulchral chamber excavated in the rock, and the work went on during the lifetime of the king for whom it was intended. A low narrow passage was kept open as the tiers of stone were added, in order that access might be obtained to the central chamber from without; and when the monarch died the work ceased, and the last layers were then finished off and the passage closed up. The angles formed by the recession of each superior layer were filled up with small stones and beveled off, so as to give a smooth sloping surface to the sides. The stones used varied in thickness from 2 feet to 4 feet, and the mechanical skill requisite to quarry these and to raise them to such great heights and adjust them in their proper places continues a matter of universal astonishment. No indication of the mechanical contrivances used for this purpose has been left, though that they possessed such can hardly be doubted. The fact that an almost fabulous number of laborers were engaged in erecting these pyramids did not lessen the necessity for the employment of certain machines. The pyramids now standing, all in Middle Egypt, are divided into five groups, containing in all about 40 pyramids. The district in which the pyramids stand begins above Dashur, and extends by Sakkara and Memphis along the western margin of the valley of the Nile for about 60 or 70 miles, the last or Gizeh group being but a few miles above Cairo. The group of Gizeh, in the neighborhood of the ancient Memphis, is the most remarkable. It consists of nine pyramids, and comprises the three most celebrated monuments of the kind in existence, namely, the pyramid of Cheops, called the Great Pyramid; that of Cephren, and that of Mycerinus — the last much smaller than either of the others. According to Herodotus the Great Pyramid was built by Cheops. It took 100,000 men working for 10 years to make a causeway 3,000 feet long, to facilitate the transportation of the stone from the Turah quarries; and the same number of men for 20 years more to complete the pyramid itself. Herodotus further describes the method of building by steps, and raising the stones from layer to layer by machines, and finally of facing the external portion from the top down. Diodorus calls the builder of this pyramid Chembes or Chabryes, and by Manetho and Eratosthenes he is called Suphis. The latter name corresponds to Shufu, deciphered from the hieroglyphics upon some stones discovered by Colonel Vyse in his important investigations of this pyramid in 1835. The pyramid at present covers an area of more than 12 acres. The base is about 750 feet square, but was formerly about 768 feet. The perpendicular height, which before the disappearance of the apex was about 482 feet, is now 451 feet. The area at the top is about 12 yards square. The outer casing of small stones has been removed, and the appearance the sides now present is that of a series of ascending steps. By these steps, which number 203, the ascent is made comparatively easy, though the lower ones are 4 feet 10 inches high. The content of solid masonry has been estimated at 82,111,000 cubic feet. The only entrance is on the north face, 49 feet above the base, though the masonry about it has been so much broken away that the débris reaches nearly up to it. A passage 3 feet 11 inches high and 3 feet 5½ inches wide conducts from the entrance down a slope at an angle of 26° 41′, a distance of 320 feet 10 inches, to the original sepulchral chamber, commonly known as the subterranean apartment; it is carried, reduced in dimensions, beyond this a distance of 52 feet 9 inches into the rock, though for what purpose remains a matter of conjecture. The sepulchral chamber is 46 feet long by 27 feet wide, and 11½ feet high. From the entrance passage another branches off and leads to several other passages and chambers. One of the latter, known as the queen's chamber, is situated about the centre of the pyramid, 67 feet above the base; it has a groined roof, and measures 17 feet broad by 18 feet 9 inches long, and 20 feet 3 inches high. The other, called the king's chamber, is reached by an offshoot from the queen's passage, 150 feet long. Its dimensions are 34 feet 3 inches long by 17 feet 1 inch wide, and 19 feet 1 inch high. The chamber is lined with red granite highly polished, single stones reaching from the floor to the ceiling, and the ceiling itself is formed of nine large slabs of polished granite extending from wall to wall. The only contents of the apartment is a sarcophagus of red granite, which, judging by its dimensions, must have been introduced when the building was proceeding. It is supposed to have contained a wooden coffin with the mummy of the king, and that these long since disappeared when the pyramids were first opened and plundered. The second pyramid, built by Suphis II. or Cephren, stands on a higher elevation than the Great Pyramid. Its original dimensions were 707 feet 9 inches square, and 454 feet 3 inches high; but these now stand 690 feet 9 inches and 447 feet 6 inches respectively, with an angle for its slope of 52° 20′. Part of the outer casing of the pyramid is still preserved. This pyramid has two entrances, and the passages to which they respectively give access lead to the same sepulchral chamber, in which is deposited a granite sarcophagus. It was reached with great difficulty by Belzoni in 1818. Belzoni found in it a Cufic inscription recording the visit of the Caliph Alaziz Othman Ben-Yusuf, and the opening by him of the pyramid in 1196 A.D. The only remains met with were those of a bull. The third pyra-



THE GREAT PYRAMIDS, NEAR CAIRO.

mid, built by Menkaré or Mycerinus, is only 354 feet 6 inches square and 203 feet high. It also was explored by Colonel Vyse in 1837. He discovered several chambers, one of which contained a sarcophagus and a mummy case bearing the name of King Menkaré, and also a body, supposed to be that of an Arab. The two latter are now in the British Museum, but unfortunately the sarcophagus was lost by the sinking of the vessel in which it was being transported to this country. This pyramid is the best constructed of the three; it was originally cased half-way up with black granite. The six smaller pyramids which complete the Gizeh group are supposed to form the tombs of some of the relatives of the kings who constructed the larger ones, and are of much inferior interest to the three above mentioned. Of the other groups of pyramids that at Abusir contains five; another at Sakkara contains eleven, one with a doorway inlaid with porcelain tiles and having a royal name; and a third group at Dashur contains five. Other pyramids are at Meydun and Illahun, and there are two at Biahmu. The pyramids of Nubia are very numerous; a single group north of Gebel Barkal comprises no fewer than 120. In Babylonia the Birs Nimrud or Tower of Belus was a kind of step-shaped pyramid, built of bricks of different colors. It was erected by Nebuchadnezzar, and dedicated to the planets. Its height was 235 feet and its circumference 2,286 feet. The Mujellibe in Babylon, of which the ruins are still to be seen, was another pyramidal structure of the same monarch. Ruins of pyramids are to be found at Benares in India and in other parts of the East. Certain monuments of the ancient inhabitants, found in Mexico, are also called pyramids. (See MEXICAN ARCHÆOLOGY.) Consult: Lepsius, 'Ueber den Bau der Pyramiden'; Vyse, 'Operations carried on at Gizeh in 1837'; Petrie, 'The Pyramids and Temples of Gizeh' (1884); Maspero, 'L'Archéologie Egyptienne' (1887).

Pyramid, in geometry, a polyhedron with a polygon as base, and triangular sides meeting in a common point called the vertex. The regular pyramid is bounded by four equilateral triangles with the vertex perpendicular to the centre of the polygonal base, and is thus a tetrahedron. The perpendicular distance between the base and the vertex is the altitude. The *slant* altitude is the height of any of the triangular sides. Pyramids are named according to the natures of their bases; they may be triangular, quadrangular, etc., according as their bases are triangles, quadrilaterals, pentagons, etc. The base and lateral triangles are called faces; the lines in which the faces meet are called edges; the points in which the edges terminate are called the vertices of the pyramid.

Pyramus (pĭr'ạ-mus) **and Thisbe**, thĭz'bē, a pair of unfortunate lovers whom classical legend represents as living in Babylon. Their parents were enemies and would not sanction the marriage of the lovers, but the two contrived to converse with each other in secret through an opening in the walls of their adjoining houses. They finally determined upon a meeting at the the tomb of Ninus. Thisbe was first to arrive and meeting a lioness who had just killed an ox she ran away, dropping her mantle in her flight. This the lioness soiled with blood and Pyramus arriving shortly after and finding the blood-stained garment of his betrothed imagined her to have been killed and ended his life beneath a mulberry tree, the fruit of which has since been of a blood-red hue. Thisbe returning finds the body of her lover, whereupon she then kills herself in despair. The legend is embodied in Ovid's 'Metamorphoses' and is caricatured in the farcical interlude in Shakespeare's 'Midsummer Night's Dream.'

Pyrargyrite, pī-rär'jĭ-rīt ("dark ruby silver"), a rhombohedral mineral, usually of high metallic-adamantine luster, color black by reflected light, rich ruby-red by transmitted light, hardness 2.5, specific gravity 5.85. It is a silver sulph-antimonite, containing 60 per cent of silver. It occurs in magnificent specimens in Germany, Mexico, Chile and Bolivia, and is an important silver ore in these countries and in the mining regions of the Western United States.

Pyrenees, pĭr'ę-nēz, a lofty mountain chain forming the boundary between France and Spain. Its length, from Cape Creux, north of the Gulf of Rosas, to the Point of Figuier, near Fuenterrabia, is nearly 270 miles; and its breadth near the centre, where it is greatest, scarcely exceeds a third of the length. Though the chain thus defined terminates at two opposite seas, it cannot be said to be isolated, since to the west it is obviously continued across the north of Spain by the Cantabrian Mountains. The direction of the chain is east-southeast, to west-northwest. It does not, however, lie in the same straight line, but rather consists of two lines, which form parallel ridges about 20 miles distant from each other, except near the centre, where they become united by means of a remarkable rectangular elbow, in which some of the loftiest summits are found. Both on the north and south sides numerous branches are thrown off, generally at right angles to the principal axis, and subside rapidly as they recede from it, forming various transverse, but very few longitudinal, valleys. The chain rises both from the east and west toward the centre; and, in accordance with a general rule which holds in regard to the European chains, which lie in the direction of the equator, the descent on the south side is much more abrupt than on the north. Owing to this the south has much fewer lakes than the north slope, but far surpasses it in the boldness and grandeur of its scenery. As already observed, the loftiest summits of the chain are near its centre. Its culminating point, Maladetta, situated there, has the height of 11,168 feet, and a great number of peaks in the same locality exceed 8,500 feet. To the east of the centre the chain lowers so rapidly that its average height soon becomes little more than 2,000 feet. To the west the height diminishes much more gradually, and many peaks have heights varying from 5,000 to 7,000 feet, and even 8,000 feet. The principal passes in the Pyrenees formed by the meeting of valleys from opposite sides of the axis, take in the east part of the chain the name of Cols, and toward the centre that of Ports. No fewer than 75 are counted, of which 28 may be crossed on horseback, and 7 in wheeled carriages. The most frequented are those of Pertus and La Perche in the east, and St. Jean Pied de Port in the west. The nucleus of the chain is evidently granite, which with the primitive schists which overlie it, constitutes the loftiest summits, with the exception of Mont Perdu (10,994 feet), Marbore (10,673 feet), and some huge adjacent masses which are formed of mountain limestone. The granite, however, seldom forms continuous ridges along the principal axis, but rather appears in a number of remarkable protuberances situated to the north of it. Above the micaceous schist and primitive limestone, which occur in connection with it, lie largely-developed strata of argillaceous schist and transition limestone, forming two great belts parallel to the primitive chain, one on the north and the other on the south side. Above these secondary rocks appear, of which by far the most common is the mountain limestone, which occupies the greater part of the south slope, but on the north side attains little elevation, being there almost entirely confined to the lower heights at the bottom of the principal chain. Above the mountain limestone the principal rocks are Jura limestone and trap. The number of thermal springs existing in the Pyrenees seems to indicate the presence of volcanic agents, but basalt and other rocks of igneous origin are very rare. The minerals of the chain include iron, copper, lead, zinc, manganese, antimony, and cobalt. There is no mine either of silver or gold, but particles of the latter are found in department Ariège, and in the streams of several other districts. The only mineral which has hitherto been worked to much advantage is iron. Mineral springs, both cold and thermal, are numerous, and much frequented by visitors. The limit of vegetation on the Pyrenees is about 600 feet higher than on the Alps. The rhododendrons, which in the latter are not found higher than 5,000 feet, are here found at 5,500 feet, and alpine plants are found on the loftiest summits bordering on the region of perpetual snow. In the Pyrenees this is found only on the north slope, where it does not, as in the Alps, form a snowy zone, the lower limit of which looks as if traced out by an almost horizontal straight line; but, on the contrary, forms large isolated masses, the base of which is often concealed by the mountains in front of them. This makes it difficult to fix the snow-line with precision, but according to the most accurate estimate it is 9,190 feet, or nearly that of Mount Canigou. Glaciers are not numerous in the Pyrenees, and hence the torrents and rivers which rise in the chain are fed chiefly by springs. Those on the south side flow toward the Ebro, and are carried by it to the Mediterranean; those on the north side flow partly to the Mediterranean and partly to the Atlantic, the water-shed between the two seas being carried northward by a branch which ultimately links with the Cevennes. The largest river of the chain, and the only one of importance which preserves its name throughout its whole course, is the Garonne. In respect of average height and mass the Pyrenees are unquestionably the second mountain chain of Europe, but its culminating point, Maladetta, has only the third place, being indeed lower than Mulhacen in the Sierra Nevada. Contrary to the general rule, that the loftiest summits of mountain chains are found in the line of the principal axis, Maladetta, Posets (11,047 feet), and Mont Perdu, the three culminating points of the Pyrenees, are situated on the south slope.

Consult: Taine, ‘Voyage aux Pyrénées,’ especially the 4th ed. (1873) with illustrations by Doré; Schrader, ‘Les Pyrénées,’ in the ‘Annuaire du Club Alpin français’ (1885); De Margerie and Schrader, ‘Aperçu de la Structure géologique des Pyrénées’ (1891), and ‘Aperçu de la Forme et Relief des Pyrénées’ (1892); Camena d'Almeida, ‘Les Pyrénées: Développement de la Connaissance géographique de la Chaine’ (1893); Trutat, ‘Les Pyrénées’ (1894); Bubanus, ‘Flora Pyrenæa’ (1897–1902); Spender, ‘Through the High Pyrenees’ (1898).

Pyrenees, Peace of the, in European history, the name given a treaty concluded between France and Spain by Cardinal Mazarin and De Haro, on the Ile des Faisans, in the river Bidassoa, 7 Nov. 1659, terminating a war which had lasted for 24 years. By this treaty Spain ceded to France Roussillon, with the fortress of Perpignan, etc., so that the Pyrenees have since formed the boundary of the two kingdoms; and in the Netherlands, Artois, and part of Flanders, Hainault, and Luxemburg, with a number of fortified towns.

Pyr'ethrum, a group of composite plants formerly considered a genus but now ranking as a section of the genus *Chrysanthemum.* In garden literature the name is generally restricted to *Pyrethrum roseum,* several hundred varieties of which are widely popular in European gardens. Under the name *Chrysanthemum coccineum* it is extensively cultivated in southern France, California and western Asia for its flowers, which are dried and ground as the material of insect powder. Another species (*C. cinerariæfolium*) is also cultivated for this purpose. The well-known bedding-plant “golden feather” is a variety *C. prœltum,* but is widely known as *Pyrethrum aureum* among horticulturists. The plants are easy to grow in any good garden soil, if deeply dug and highly enriched. Since the seed is often disappointing in its results, the plants are best propagated from choice varieties by division in the spring. The golden-feather pyrethrum is often propagated by cuttings made during the winter from stock plants.

Pyrgos, pĭr'gōs, Greece, capital city of the nomos of Elis, 13 miles west of Olympia, on the west coast of the Morea, near the mouth of the Ruphia (Alpheus), on the railroad from Piræus to Olympus, and with branch connections with its harbor, Katakolon. The surrounding country is a fertile plain, growing currants, oranges, and grapes. The commune has a population of about 27,000; the town, 13,000.

Pyrheliom'eter, an instrument for measuring the intensity of the heat of the sun. It is a shallow, circular vessel of silver, having one side coated with lampblack, containing mercury or water, and having a thermometer let into it.

Pyr'idine (C_5H_5N), a mobile liquid, boiling at 117°, obtained by the distillation of various organic substances, such as peat, bone, coal naphtha, etc. It has an alkaline reaction, and forms salts with acids.

Py'rite, or **Iron Pyrites,** the commonest metallic mineral, like copper pyrites, is often called “fool's gold,” owing to its resemblance to gold. It may readily be distinguished by its much greater hardness, 6 to 6.5, brittleness, pale brass-yellow color, greenish-black streak, and specific gravity, 4.95 to 5.10. It crystallizes in isometric crystals often of great beauty, but is usually found massive as a vein material or in beds of great extent. It is an iron disulphide, FeS_2. Its high sulphur percentage, 53.4, and the ease with which it may be burned, leads to its enormous consumption in the manufacture of sulphuric acid. Owing to its ready oxidation, it is an active agent in the disintegration of those rocks through which it is disseminated. It frequently contains gold and to some extent other valuable metals. Its most importance commercial occurrence is at Rio Tinto, Spain. It is also extensively mined near Rowe, Mass., in Virginia, the Carolinas, Georgia, Colorado and in many other regions. The finest crystals come from Elba, Cornwall in England, Peru, Chester County, Pa., and Central City, Colo.

Pyrites, either of the various metallic sulphides, of which the most important is iron pyrites (see PYRITE). Copper pyrites (see CHALCOPYRITE) is an important ore of copper. Arsenical pyrites (see ARSENOPYRITE) furnishes much of the arsenic of commerce; magnetic pyrites (see PYRRHOTITE) is often an important nickel ore.

Pyrmont, pėr'mōnt, Germany, a celebrated watering-place of Prussia, in the principality of Waldeck and Pyrmont, capital of the district; in a beautiful valley at the foot of a range of finely wooded hills, on the left bank of the Emmer, 34 miles south-southwest of Hanover. It contains a palace, in which the Prince of Waldeck and Pyrmont resides during the watering season; and it is much frequented, particularly by the aristocracy of Germany; from 10,000 to 20,000 visitors are here annually. One of the curiosities of the place is the Dunsthöhle or gas grotto, which emits vapors similar in nature and effect to those of the Grotto del Cane in Italy. Pop. (permanent) 1,500.

Pyrochlore, a dark brown, resinous mineral of complex composition, essentially a cerium and calcium niobate, but of interest because containing also thorium and uranium. It occurs in octahedrons in Norway and Russia.

Pyrogal'lic Acid, Pyrogallol, Tri-oxy-benzene, $C_6H_3(OH)_3$, is produced by action of heat on gallic acid, carbon dioxide being eliminated in the process. Fine colorless needles or plates, readily soluble in water, less so in alcohol or ether, melting point 132° C. Valuable because of its great affinity for oxygen, its alkaline solution is used to absorb oxygen in gas analysis. It is used extensively as a photographic developer, but has the disagreeable power of darkening the skin. It forms a number of derivatives, some being valuable dyestuffs.

Pyrog'raphy, from πῦρ, fire, and γράφειν, to write, literally to write by fire. A method of making impressions on wood, leather, etc., by means of heated metallic instruments. The art was early practised by the Egyptians who used crude iron bars that had been previously heated in fire. The modern form of this kind of apparatus consists of a tube about six inches in length and about half an inch in diameter provided at its lower extremity with a screw-cap and a small support. At the other end there is a rod to which the drawing point is affixed. For the formation of the combustible gas and heating of the rod sulphuric ether is usually employed. The gas when generated is forced to the metallic point by means of air pressure and after the flame has been regulated a person may work for two consecutive hours at an expense of about one half cent per hour. The vapors disengage themselves constantly and feed the small flame which is barely perceptible. The heat is always uniform, and even on leather a sure and sharp execution of the design is possible. The effects produced by the pyrograph are equal in many respects to the fine crayon drawings, and when colored and varnished present a very pleasing effect. The finest and most delicate lines can be drawn and there is no danger of burning holes in the material. The right hand being engaged in the execution of the piece to be ornamented leaves the left free to turn the object in any desired position while the work is in progress.

From a commercial standpoint, work in pyrography offers very good returns. It is taught in most of the trade schools, and by many private masters, and those who apply themselves systematically may use their accomplishment with profit. Apart from the artistic and financial interest the work has a substance and lastingness about it that makes it seem worth while to master.

Pyrolig'neous Acid, impure acetic acid produced as one of the volatile products of the destructive distillation of wood. The wood is slowly heated in large iron retorts or ovens so arranged that the volatile products may be condensed and gathered. The watery portion contains wood alcohol and acetic acid mixed with small amounts of such impurities as carbolic acid, creosote, and the like. On redistillation the wood alcohol passes over first, leaving the impure acetic acid or pyroligneous acid in the retort. This may be purified (see ACETIC ACID) or used as such for various purposes such as the impregnation of wood to prevent decay, etc.

Pyrolu'site, the most important ore of manganese. It is a black or gray mineral of brilliant metallic lustre. It is distinguished from manganite and polianite, which it much resembles, by being so soft (hardness 2 to 2.5) as readily to soil the fingers. Its black streak further separates it from manganite. While its crystallization is orthorhombic, it is usually massive or radiating-columnar. Chemically it is manganese dioxide, MnO_2. It has long been used in the manufacture of chlorine and oxygen, and in decolorizing glass; its present most important use is in the preparation of manganese-steel. It occurs abundantly in Thuringia and elsewhere in central Europe, also in Nova Scotia and Brazil. In the United States it is mined in Virginia, Georgia and Arkansas.

Pyroma'nia, incendiary monomania, a form of insanity characterized by an irresistible desire to destroy by fire. In most forms of mental disease self-control is lost, but in pyromania the loss of the power of inhibition is the chief symptom; hence the affection is sometimes spoken of as a form of inhibitory insanity.

Pyrom'eter, an instrument for measuring temperatures higher than the boiling-point of mercury (350° C.). Regnault and other careful experimenters employed the expansion of air and vapors in measuring high temperatures. These pyrometers can only be used in a laboratory; for use in a manufactory less accurate methods of measurement have to be employed. In Wedgwood's pyrometer (1782) it was assumed that dry clay, when exposed to heat, contracted regularly, and the instrument was constructed on this principle; but it is now known to be untrustworthy. An instrument in which the expansion of a metal bar (generally of platinum) was magnified by means of levers has often been employed to measure the temperature of a furnace. Morveau, Brongniart, and Daniell invented instruments on this principle. The thermo-electric law of Tait may be used to calculate the temperature to which a junction of copper and iron has been subjected, the electric current produced being measured by a galvanometer. In this way high temperatures have been measured with considerable accuracy. By Siemens' method temperatures are measured by observing the increased electric resistance of a platinum wire when heated, two coils of the same kind of wire being prepared so as to have equal resistances at the same temperature, their ends connected by rather long thick copper wires, and the current from a constant battery passing through them measured by means of a galvanometer. One of the coils is kept at a known temperature, the other has the temperature which it is desired to measure. The law discovered by Siemens —

$$R = \alpha\sqrt{T} + \beta T + \gamma$$

where R is the resistance at the absolute temperature T, and where α, β and γ are certain numbers, enables the temperature to be calculated. Pouillet determined the following temperatures by means of an air-thermometer. They correspond to the stages of incandescence of a metal bar.

Incipient red-heat	525° C.
Dull red	700°
Cherry red	900°
Dark orange	1100°
White	1300°
Dazzling white	1500°

Pyromor'phite, a mineral occurring in hexagonal crystals, often cavernous and barrel-shaped, or in curious nearly parallel groups tapering to a point. It is a lead phosphate and chloride and occasionally occurs in sufficient quantities to be an important lead ore. Its hardness is 3.5 to 4, specific gravity, 6.5 to 7.1, color commonly green, yellow or brown, lustre resinous. Its most notable occurrences are Ems, Germany; Cumberland, England; Broken Hill, New South Wales, and in the United States formerly at Phœnixville, Pa.

Pyrope, or **Bohemian Garnet,** a fine dark-red variety of garnet, often called "precious garnet" because of its extensive use as a gem. Peridotite, or serpentine derived from it, is the usual matrix of pyrope in Bohemia and in Kimberley, South Africa, but more commonly it occurs as rounded pebbles loose in the sands, as in the ant-hills of the Navajo Reservation in Arizona. It is often incorrectly called "ruby." See CARBUNCLE.

Py'rophone, a musical instrument, in which the various notes are produced by the burning of hydrogen gas within glass tubes of various sizes and lengths. It is also called a flame-organ, and was invented about 1875 by a Frenchman called Kastner.

Pyrophyllite, or **Pencil Stone,** a mineral of soapy feel, the compact form of which is extensively mined in North Carolina as soapstone. Its uses are the same as those of the related mineral talc (q.v.). Some of the algamatolite used by the Chinese for carving into pagodas and images is pyrophyllite. The mineral is usually found in coarse lamellar radiations, occurring thus in fine specimens in Switzerland, Georgia, North Carolina and California. Chemically, it is a hydrous aluminium silicate.

Py'roscope, an instrument for measuring the intensity of heat radiating from a hot body, or the frigorific influence of a cold body. It is constructed on the same plan as a differential thermometer.

Pyro'sis, or **Waterbrash,** a disorder of the stomach attended with a sensation of burning in the epigastrium, commonly called heartburn, accompanied with an eructation of watery fluid, usually insipid, but sometimes acrid. See DYSPEPSIA.

Pyrotech'nics, a term applied to the composition, structure, and use of fire-works. The ingredients are nitre, sulphur, and charcoal, together with filings of iron, steel, copper, zinc, and resin, camphor, lycopodium, etc. Gunpowder is used either in grain, half crushed, or finely ground, according to the desired effect. The proportions of the materials differ very much in different fire-works, and the utmost care and precaution are necessary in the manufacture. Lampblack produces a very red color with gunpowder, and a pink with nitre in excess. It serves for making golden showers; yellow micaceous sand serves for the same purpose. Verdigris imparts a pale green, sulphate of copper and sal-ammoniac a palm-tree green. Camphor produces a very white flame, with aromatic perfumes, which mask the bad smell of the other ingredients; benzoin and storax are also used on account of their agreeable odor. Lycopodium, which is often used in the manufacture of stage-lightning, burns with a rose color and a magnificent flame. Sky-rockets, an important feature of pyrotechnics, will be found fully described in the article PROJECTILES.

Py'roxene, a mineral formed commonly in crystalline limestone or dolomite, in serpentine and in rocks of volcanic origin. Less abundant in granitic rocks and metamorphic schists. Crystalline form, monoclinic. Brittle. Hardness, 5 to 6. Specific gravity, 3.2 to 3.6. Of a vitreous or resinous lustre. Color is usually some dull shade of green, but may vary to nearly colorless or to brownish back. Composition, a metasilicate, $RLiO_3$, where R is Ca, Mg, Fe, sometimes Mu or Zn, rarely the alkali metals. Important varieties of pyroxene are diopside, hedenbergite, schefferite, augite. Pyroxene is one of the most important of the rock-forming minerals being an essential constituent of basalt, diabase trachyte, syenite, gabbro, pyroxenite and many other rocks. It is thus widely distributed in all parts of the world. Especially fine crystals occur in the Piedmont, in Sweden, northern New York and southern Canada, and in New Jersey.

Pyroxene Group, a name given to a group of minerals of which the mineral pyroxene is an important member. Composition, simple silicates of the type $RSiO_3$ where R is Ca, Mg, Fe, sometimes Mu, or Zn, or compound silicates of the types $R''(FeAl)_2SiO_6$ or $R'Al(SiO_3)_2$. While the species included in the pyroxene group belong to three distinct crystal systems — orthorhombic, monoclinic, and triclinic — they all have a prismatic angle of 87°, parallel to which cleavage is usually eminent. They are distinguished further by their optical properties. The most important species in the pyroxene group are enstatite, hypersthene, pyroxene, acmite, spodumene, wollastonite, pectolite, and rhodonite.

Pyrox'ylin. See GUN-COTTON.

Pyrrhic (pĭr'ĭk) **Dance,** a famous war-dance of antiquity. It was danced to the sound of the flute, and its time was very quick and light. It was introduced into the Roman public games by Julius Cæsar, and was danced by male and female dancers, having much of a dramatic character. In the mountainous districts of Thessaly and Macedonia a dance called the Romaika, which is supposed to be a modern relic of the Pyrrhic dance, is performed by men armed with muskets and swords.

Pyrrhic Victory, so called from the defeat of the Romans at Asculum 279 B.C. by Pyrrhus, whose losses however were so heavy that the term has become proverbial for a fruitless victory.

Pyrrho, pĭr'ō, Greek philosopher: b. Elis about 376 B.C.; d. about 270 B.C. He was a pupil of the Democritean philosopher Anaxarchus of Abdera, whom he accompanied to India in the train of Alexander the Great. During this journey he became acquainted with the doctrines of the Brahmans, Magi, and other eastern philosophers. His doubts concerning positive knowledge were strengthened as he proceeded in his studies, until at length he came to hold all knowledge uncertain, and considered virtue alone as valuable. In all disputes his answer to his opponents was, "What you say may, or may not, be true; I cannot decide," and he taught in his school that truth could not be attained, and that we must be content to suspend our judgment on all subjects. He spent much of his life in solitude, and by abstaining from all decided opinions concerning moral and physical phenomena, endeavored to attain a state of tranquillity unaffected by fear, joy, or sorrow. His countrymen, the Abderites, made him high-priest, and exempted all philosophers from the payment of taxes. The Athenians erected a statue in honor of him, and his countrymen raised a monument to his memory. His skepticism is easily accounted for. His master, Democritus, held that except the immediate elements of bodies (atoms) nothing was real, and that all perception was subjective. He was confirmed in these views by the doctrines of Socrates, to whom, in his character, he bore great resemblance, and his skepticism is allied to the irony of that philosopher. Led by his temperament and manner of life to esteem uninterrupted tranquillity the great object of all philosophy, believing that nothing tended so much to destroy this quiet as the interminable disputes of the schools of the dogmatists, and that uncertainty was increased by their contentions, he determined to seek in some other way the peace which he despaired of finding in dogmatical philosophy. A disposition to doubt is often called, from this philosopher, Pyrrhonism.

Pyrrhonists. See RELIGIOUS SECTS.

Pyrrhotite, pĭr'ō-tīt, or **Magnetic Pyrites,** a metallic mineral, in composition an iron sulphide, probably $Fe_{11}S_{12}$, differing from common iron pyrites, FeS_2, in percentage composition, in being attracted by the magnet, in its bronze color, inferior hardness (3.5 to 4.5), and specific gravity (4.6). It rarely crystallizes in hexagonal, tabular crystals; usually it occurs massive. Though pyrrhotite contains over 60 per cent of iron and nearly 40 per cent of sulphur, it is only very recently that it has been regarded as of any value for these ingredients. Its commercial value was due entirely to the occasional presence as an impurity of varying percentages of nickel. Formerly the deposits of nickeliferous pyrrhotite at the Gap Mine, Pennsylvania, were extensively worked, but the far richer and more extensive deposits at Sudbury, Ontario, are now the chief sources of nickel. Enormous beds of copper-bearing pyrrhotite, nearly free from nickel, are successfully worked in Vermont. Choice crystallized specimens are found in Austria, Brazil, and at Tilly Foster, New York.

Pyrrhus, pĭr'ŭs, Greek military leader, king of Epirus: b. about 318 B.C.; d. Argos 272 B.C. He was the son of Æacides, who traced his descent from Pyrrhus, son of Achilles. He spent an eventful youth, regained the throne from which his father had been deposed, and was himself expelled several years later. He became the friend of Demetrius Poliorcetes, whom he accompanied on the fatal campaign closed by the battle of Ipsus (301 B.C.), then proceeded to Egypt as hostage for Demetrius, and there married Antigone, daughter of Queen Berenice. With the aid of Ptolemy Soter he recovered his kingdom (296), agreeing to share the sovereignty with Neoptolemus, who had been king since his expulsion, but soon after put his colleague to death, and succeeded by courage, affability, and generosity in gaining the admiration of his soldiers and people. He temporarily conquered Macedonia and in 280 went to southern Italy at the head of a large army to assist the Tarantines against the Romans. Near Heraclea, on the Siris, the consul M. Valerius Lævinus was defeated by Pyrrhus, whose elephants played an important part in the conflict. Another battle was won, but his loss led Pyrrhus to say, "Another such victory and I must return to Epirus alone." He made proposals of peace to the senate, which were rejected. After having approached within 24 miles of Rome he returned to Tarentum. In 279 he again defeated the Romans, but was glad to accept the offered truce, and passed with his army into Sicily, where he assisted the Greeks against the Carthaginians. At first he met with brilliant success; but his attack upon Lilybæum failed. The war ended in the following year with the total defeat of Pyrrhus by the Romans under Curius Dentatus, near Beneventum. On this occasion the famous elephants of Pyrrhus rushed back upon his own army and contributed to his loss. He reached Epirus with a small remnant of his once splendid army. Nothing daunted, he again invaded Macedonia, and became its king a second time. He afterward turned his arms against Sparta, but was driven from before the walls of that city. In a night attack made upon Argos he was stunned by a tile thrown by a woman from a house-top, and being recognized by the enemy's soldiers was slain.

Py'rus, or **Pirus,** a genus of fruit-bearing shrubs and trees of the rose family. There are about 40 species, natives of the northern hemisphere and especially of the cool temperate parts. They have usually simple leaves, clusters of showy white, pinkish or bluish flowers after the leaves appear, and fleshy fruits (pomes). Horticulturally this is one of the most important of plant genera, since it includes the apple, pear, quince, and medlar (qq.v.). The last two, however, are often separated into distinct genera. Some of the species, as crab apples, are cultivated for ornament.

Pythagoras, pĭ-thăg'ō-ras, Greek philosopher: b. Samos about 582 B.C.; d. about 507. His father, Mnesarchos, was a merchant (probably of Tyre or some other Phœnician city) who traded with Samos, where he received the rights of citizenship, and settled with his family. The biography of Pythagoras is mingled with many fables. He received his first instruction from Creophilus in his native city. He then went to the island of Scyros, and was a scholar of Pherecydes till the death of the latter; others make him also a scholar of Thales and Anaximander. Iamblichus says that Pythagoras, during his journey to Egypt, spent some time in Phœnicia in intercourse with the successors of Moschus, and other priests of the country, by whom he was initiated into their mysteries, and that he traveled through various parts of Syria in order to become acquainted with the most important religious usages and doctrines. He is said to have been recommended by Polycrates, king of Samos, to the Egyptian king Amasis. In Egypt he became acquainted with the whole range of Egyptian learning. He remained in Memphis and Thebes 22 years, and was in Egypt when that country was conquered by Cambyses. Like many others of the sages in that kingdom, he was carried captive to Babylon, where he conversed with the Persian and Chaldæan Magi; and traveled as far as India, and visited the Gymnosophists. After his return he opened a school at Samos, in which he taught his doctrines in a symbolic form, in imitation of the Egyptians. He also visited Crete, where the priests of Cybele took him to the caverns of Ida, in which Jupiter had been cradled. Here he met Epimenides, whom he initiated into the sacred mysteries of the Greeks. From Crete he went to Sparta and Elis, and from thence to Phlius, where, being asked by King Leon what was his profession, he replied that he was a philosopher (or lover of wisdom), declaring that the name of sage (*sophos*) belonged solely to the Divinity. With augmented knowledge he returned home, where he now founded a philosophical school with great success. He laid claim to supernatural powers, and his extraordinary qualities gained over great numbers of the noble and wealthy classes. Three hundred of these were formed into a select fraternity or order, which has been frequently compared with the still more famous order founded by Loyola in modern times. The members were bound by a vow to Pythagoras and each other, for the purpose of cultivating the religious rites and ascetic observances of their master, and of studying his system of philosophy. They thus formed at once a philosophical school and a religious order, which in time assumed the character and exercised the influence of a political association also. This influence, which became very considerable, was constantly exerted in the interest of the aristocratic party. The democratic party (perhaps, also, at times, an unfriendly aristocratic faction) reacted against the growing power of the order. At the head of this opposition party in Crotona was Cylon, a rich and respectable citizen, whose enmity Pythagoras had excited by refusing to receive him among his scholars. In revenge Cylon once attacked the house of Milo, where a number of Pythagoreans were assembled, surrounded it with his partisans, and set it on fire. Forty persons perished, and but few escaped. Pythagoras was probably not in the house. Other authorities set down this event long after the death of Pythagoras, who, they say, was simply banished by Cylon to Metapontum. He fled to the Locrians, and when these refused to receive him, to Metapontum, where, according to tradition, he perished from hunger. Consult: Lewes, ‘Biographical History of Philosophy’; Grote, ‘History of Greece’; Zeller, ‘Pre-Socratic Schools.’

Pythagoras of Rhegium, rē'jĭ-ŭm, Greek sculptor: b. Samos toward the end of the 5th century before Christ. He was noted for his skill in giving the finest and justest proportions to his statues which often represented the human body in attitudes most difficult to represent. Such were his ‘Limping Philoctetes’ (in bronze); his ‘Apollo in Combat with the Dragon’; his ‘Duel of Eteocles and Polynices’; ‘Europa and the Bull.’ His favorite subjects were victors in the public games, and it was his habit as an artist to elaborate the details of his figures; he was learned as an anatomist and in his statues the hair, sinews, and even veins were represented with life-like distinctness and individuality.

Pythagore'an Theorem, the 47th proposition of the first book of Euclid's Elements, which shows that in any right-angled triangle the square on the hypotenuse is equal to the sum of the squares on the other two sides.

Pythagore'anism, the philosophical doctrine of the Pythagoreans, or followers of Pythagoras (q.v.). The system of the Pythagoreans was comprehensive and included a theory of being, that is, a metaphysic; a cosmological theory; and a mathematical theory.

Pythagorean Metaphysics.— The Pythagoreans taught that the essence of all things was number; that everything in its final analysis could be resolved into number. This statement, which is recorded in Aristotle's Metaphysics, where he is enumerating the Greek schools of philosophy, has occasioned much dispute. We may perhaps see in this doctrine the basis of the 10 antitheses of Pythagorean teaching, especially that of the opposites, odd and even, the definite and indefinite, which are placed first in the list. Number was also an idea in which these opposites were each included, and was therefore sometimes spoken of as harmony. But other interpretations of the Pythagorean number make unity and duality as the root notion, and pronounce that these terms may be reduced to the opposition of the spiritual and corporeal, of form and substance, of the Supreme Being and the material world. The Deity is the one, the Original Unity, the Infinite, out of which all finite things have come. The opposition between the limited or finite, and the unlimited or infinite is by some philosophers regarded as the fundamental idea in the Pythagorean number. It is possible that the doctrine was from the first propounded as a vague generalization which might be and was interpreted in different ways by different members of the school. It is evident that nothing can exist without number, as is stated in the apocryphal Book of Wisdom, in some respects a product of Alexandrian Neo-Pythagoreanism. The numbers themselves are divisible into odd and even, and thus suggesting the contrast between the limited and unlimited, the conditioned and the unconditioned, the relative and the absolute, matter and spirit, man and God. On the other hand, it is possible that the Pythagorean number was not arithmetical but geometrical. The great disciple of Pythagoras in the time of Socrates was Philolaus, but of the writings in which he expounded his views only fragments survive, and these are of doubtful authenticity. Philolaus may have been under the influence of Democritus, and his theory of number have been based on geometrical axioms, and the intervals in the sounds struck from the seven-stringed lyre. Probably he was an atomist. The individual atom would in that case represent to him a material spatial point, two of which made a line, three a surface, four a solid; of these solids. represented always by even numbers, the constituents of earth were cubical; those of fire tetrahedral, those of water icosahedral, etc. From the use of numbers as the ontological basis of things the passage was easy enough to the wild and fanciful application of them as mere symbols. Thus the later Pythagoreans made the soul correspond with the number six, while seven was the counterpart of reason and health. The imagination here stepped in and with curious ingenuity labored to give a rational basis to these axioms. Hence the famous oppositions of this philosophical sect; namely (1) limited and unlimited; (2) even and odd; (3) one and many; (4) right and left; (5) male and female; (6) rest and motion; (7) straight and crooked; (8) light and darkness; (9) good and evil; (10) square and rectangle. It will be perceived that in these oppositions the idea of completeness, as represented by an even number, and incompleteness by an odd number is the ruling element, and in the idea of incompleteness is implied the potentiality of indefinite extension, multiplication, or variation.

Pythagorean Cosmology.— Pythagoras, or at least the Pythagoreans, had some vague idea of a heliocentric solar system. They taught that the universe had as its centre a fire round which the earth and stars revolved. This central fire was not identified with the sun; the stars were luminous from reflecting its light. They taught that this fire was not visible from the earth; that there was a counter earth which made up with the five known planets, the fixed stars, sun, and moon 10 celestial phenomena. The distance of the spheres from the central fire was determined according to simple numerical relationships. The harmony of the spheres was a melodious sound resulting from the revolution of the heavenly bodies in accordance with the intervals of their distance from the central fire. The Pythagoreans discovered the connection between the length of the string in a lyre and the character of the note which was sounded on percussion. They taught the transmigration of souls.

Pythagorean Geometry.— The Ionic school of Greek philosophy imported geometry from Egypt into the Greek world of intellectual activity. Its early development in Europe was mainly due to the followers of Pythagoras, who himself enunciated the theorem now known as the 47th proposition of the first book of Euclid. The three proportions, arithmetical, geometrical, and harmonical were known to them and the so-called most perfect proportions, such as $6:8 = 9:12$, were familiar to them, having been introduced into Greece by Pythagoras who learned it from its inventors the Babylonians.

Pytheas, pĭth'ĕ-as, Greek navigator: b. Massilia (Marseilles) in the 4th century B.C. He made two voyages of discovery along the western coast of Europe from Gibraltar to Iceland. The first voyage extended along the western coast of Europe, through the English Channel, and after somewhat extensive explorations in Britain he proceeded northward and reached Thule, which seems identical with Iceland. Here he was deterred from farther advance by dense fogs and considered himself to have reached the point where the earth ended. He described the fog as a molluscous substance, in which earth, air, and sea mingled and in which the universe was suspended. His second voyage seems to have extended along the coast of Denmark and to the Baltic. His accounts of his voyages were received as fables by the ancients, and, though celebrated as a navigator and mathematician, little is known of him excepting through the brief and adverse criticism of later writers, among whom are Strabo and Pliny. His accounts were without doubt in the main correct, but the loss of his works makes it difficult to ascertain his real status. He was said to have been the first to determine the sun's meridian altitude at Marseilles at the summer solstice by means of a gnomon. The scanty fragments remaining of his writings were published by Arvedson (1824).

Pyth'ian Games, in ancient Greece, a name given one of the four seasons of games, instituted in early times in honor of Apollo, the conqueror of the Python. They were celebrated in the neighborhood of Delphi (formerly called Pytho), in the Crissæan fields, which for this purpose contained a hippodrome or race-course; a stadium of 1,000 feet in length; and a theatre, in which the musical contests took place. According to the popular mythological legend the Pythian Games were instituted by Apollo himself. They seem to have been originally only a musical contest, which consisted in singing a hymn to the Pythian god. Until about 586 B.C. they were under the management of the Delphians, and took place at the end of every eighth year; but after that date they were conducted by the Amphictyons, and were celebrated at the end of every fourth year, and prizes were added for flute-playing, athletic sports, and horse and chariot racing. Eventually contests in tragedy and other kinds of poetry, painting, sculpture, and historical narratives were introduced. At first the prizes were silver or gold, but afterward they consisted of the laurel wreath and the symbolic palm-branch. The statues of the victors were erected in the Crissæan plain. They continued to be celebrated, it is believed, until the end of the 4th century.

Pythias, pĭth'ĭ-ạs. See DAMON AND PHINTIAS.

Pythias, Knights of. See KNIGHTS OF PYTHIAS.

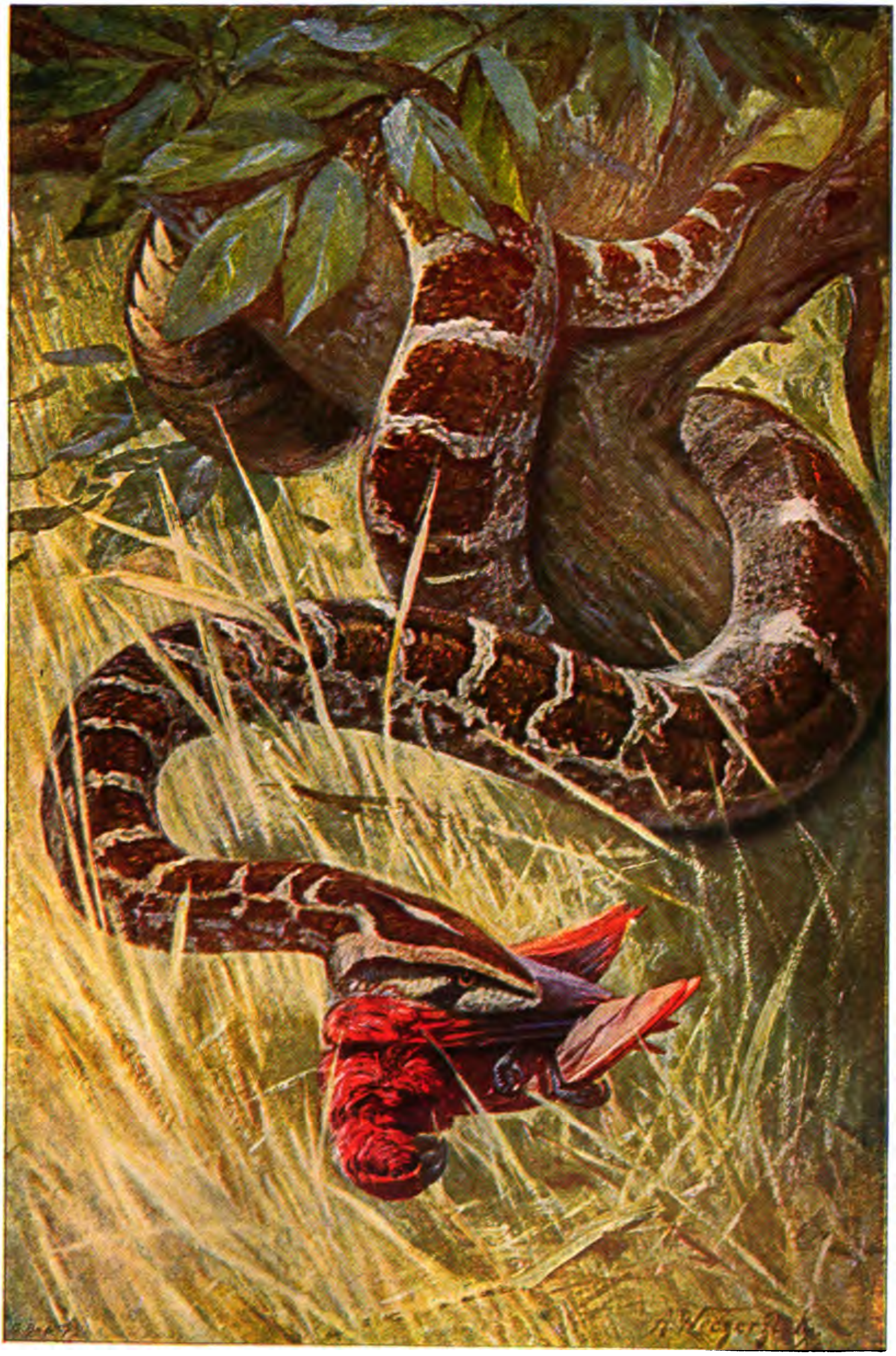
Py'thon, a genus of serpents included in the family *Boidæ,* and the popular name for the same. They form a subfamily (*Pythonidæ*) distinguished from the true boas by having teeth in the premaxillary bone, a pair of supraorbital bones, and the ventral plates of the tail mostly in two rows. With one exception all the pythons belong to the Old World, while the boas occur in both hemispheres. These snakes may possess more than 400 vertebræ, and *P. reticulatus,* of the Malay Islands, and *P. molurus,* of India and Ceylon, may attain a length of 30 feet. A rudimentary pelvis and traces of hinder limbs exist in the pythons, these structures teminating externally in a kind of hooked claw, which, together with the short prehensile tail, adapt them to arboreal habits.

Although destitute of any venomous qualities, these snakes are greatly dreaded on account of their enormous strength. They suspend themselves from the branches of trees, generally in the neighborhood of water, and lie in wait ready to pounce upon animals which come to drink. The body is wound round the victim, which is crushed into a shapeless mass by the powerful constricting folds of the snake. Greatly exaggerated stories of the huge bulk which these serpents are able to swallow have been circulated, but no doubt a goat or sheep can readily be disposed of. The teeth of these serpents are simply conical recurved structures, which, while useless for mastication, will tend to fix and retain the prey in the mouth, and prevent its egress during the movements of swallowing. The jaws may, through the loose and disjointed arrangement of the squamosal and quadrate bones, be very widely separated from the skull, so as to largely increase the size of the mouth from above downward; while the halves of the lower jaw being but loosely connected by elastic ligaments, the cavity of the mouth can thus be greatly enlarged from side to side also. The throat is also exceedingly distensible, and from a consideration of the foregoing points it is easy to conceive how the bodies of even large animals may be slowly and gradually swallowed. The process of deglutition once begun is largely mechanical. The snake neither sees nor tastes the object, and the mandibles work back and forth alternately to force it down the throat, and largely independently of the snake's will. Thus a number of cases are on record in which blankets, having become entangled in the teeth of large serpents, were reluctantly swallowed and caused their death.

Pythons lay numerous eggs, about which the female coils more to protect than to incubate them. This habit is frequently observed in zoological gardens. The African pythons rarely exceed 12 or 15 feet. Others occur in Australia. The only American representative of the subfamily is *Loxocemus bicolor,* of Mexico and Central America. Consult: Bumpus, 'Standard Natural History,' Vol. III. (Boston, 1885); Boulanger, 'Fauna of British India' (London, 1890). See BOA.

Pyx, anciently any casket and in particular a jewel-case. The present significations of the word are: (1) The vessel, of gold or silver-gilt, in which, in Catholic churches, the blessed sacrament is reserved; called also ciborium; and the small silver-gilt vessel in which the host is carried to the sick for administration at their homes. In former times the pyx had the forn of a dove and was suspended above the altar; in present usage it is reserved in the tabernacle or shrine above the high altar. (2) The box or chest in which, at the English mint, specimens of the coinage are deposited, to be tested by a jury of goldsmiths about once in three years; this test is called the "trial of the pyx."

Pyxie. The pyxie, or flowering moss (*Pyxidanthera barbulata*), is one of the most beautiful and early-flowering plants of the moist, sandy, pine-barren regions of New Jersey and North Carolina. It is found only in certain localities even in this restricted district, but is abundant in its chosen haunts, blooming in April. The pyxie belongs to the *Diapensia* family, very closely related to the heather tribe, and is a small, evergreen, shrubby plant, lying, cushion-like, flat on the sand, and having long, tapering branches trailing in all directions. The small, rigid, pointed leaves are tinged with red at blossoming time, and are very numerous, but are nearly hidden by the profusion of waxen, symmetrical, five-lobed flowers, coral-tinted in the bud, creamy white when open. The twin anther-cells of the five anthers are globose and transversely valved, whence the Greek generic name, meaning box-anther.



PYTHON (*Python molurus*)

Q

Q the seventeenth letter of the English, Latin and other alphabets of western Europe. As in Latin so in English it is always followed by the vowel *u*: as in English so probably in ancient Latin *qu* was equal to *cu* or *kw*: *q* is therefore a superfluous letter and has no place in a scientific alphabet, save as standing for some sound differing from that of *k*: in A. J. Ellis's palæotype alphabet *q* stands for nasal *ng*. Some of the ancient Latin grammarians regarded Q as a contracted form of CV (that is *cu*); but others, and with them modern philologists recognize in Q a modified form of the koppa of early Greek Ϙ, derived from the Phœnician alphabet. This character occurs in very ancient Latin inscriptions; but later the down stroke was written aslant, Q, whence the form Q. Q was not employed in Anglo-Saxon writing, *cw* being used instead: *cwén*, queen; *cwellan*, to quell; nor was it used in early Teutonic writing, except for words borrowed from Latin; but afterward words of native Germanic origin were spelled with *q*: *quälen*, to torment; *quer*, athwart.

Qua (kwä) **Bird.** See HERON.

Quackenbos, kwăk'ĕn-bŏs, **George Payn**, American educator: b. New York 4 Sept. 1826; d. New London, N. H., 24 July 1881. He was graduated at Columbia in 1843 and admitted to the bar. Later he abandoned law and for many years conducted a large private school in New York. He published: ‘Advanced Course of Rhetoric and Composition’ (1854); ‘School History of the United States’ (1857); ‘Natural Philosophy’ (1859); and many other once popular text-books.

Quackenbos, John Duncan, American physician: son of G. P. Quackenbos (q.v.): b. New York 22 April 1848. He was graduated from Columbia in 1866 and from the College of Physicians and Surgeons in 1871, and has since practised in New York. He became adjunct professor of English at Columbia in 1884, and was professor of rhetoric in Barnard College 1891–3. He is a specialist in mental diseases and has published among various other works, ‘History of the World’; ‘History of Ancient Literature’; ‘Tuberculosis’; ‘Typhoid Fever’; ‘New England Roads and Roadside Attractions’; ‘Hypnotism in Mental and Moral Culture.’

Quackenbush, kwăk ĕn bŭsh, **Stephen Platt**, American naval officer: b. Albany, N. Y., 23 Jan. 1823; d. Washington, D. C., 4 Feb. 1890. He entered the navy as midshipman in 1840, received rank as lieutenant in 1855 and lieutenant-commander in 1862. In the early part of the Civil War he had charge of the Delaware, Unadilla, Pequot, Patapsco, and Mingo in the blockading squadron, covered Gen. Burnside's army at Aquia Creek and Roanoke Island, participated in the battles at Elizabeth City and New Berne, N. C., engaged the Confederate batteries at Winton, N. C., and destroyed the town. He later took part in the engagements at Sewell's Point landing, Wilcox landing, and Malvern Hill, and received at the last mentioned place a wound from which he lost his right leg. In 1863 he captured the Princess Royal loaded with materials for a Confederate ironclad. In 1864 while dredging Charleston harbor for torpedoes his ship, the Patapsco, was struck by a torpedo and sunk. Later he was in command of the Mingo, protecting Georgetown, S. C. He became rear-admiral in 1884 and was retired in 1885.

Quadi, kwä'dī, an ancient powerful people of southeastern Germany, of the Suevic race. They inhabited the country bounded by Mount Gabreta, the Hercynian forest, the Sarmatian mountains, and the Danube; their neighbors being the Gothini and Osi on the north, the Jazyges Metanastæ on the east, the Pannonians on the south, and the Marcomanni on the west. With the last named people they were on terms of alliance. In the reign of Tiberius the Romans erected a kingdom of the Quadi; but in the reign of Marcus Aurelius the Quadi joined the great German confederacy against the empire, and in 174 were on the point of destroying the imperial legions in a great battle when a sudden storm, attributed to the prayers of the Christian soldiers in the emperor's army, enabled the Romans to recover from their confusion and achieve a complete victory. The independence of the Quadi was recognized by Commodus in 180. They disappear from history about the close of the 4th century.

Quadrages'ima, the period of the 40 days' fast preceding Easter: the season has a like name in Greek, *Tesserakosté*, fortieth. The first Sunday of Lent is sometimes called Quadragesima, but in the Roman calendar it is *Dominica prima Quadragesimæ*, first Sunday of Lent: and the Sundays following are denominated respectively, the second, third, and fourth of Quadragesima, Passion Sunday (*Dominica Passionis*), and Palm Sunday (*Dominica Palmarum*). In the Book of Common Prayer these six Sundays are called the first, second, third, fourth, and fifth of Lent and "Sunday next before Easter"; but this Sunday is also styled in England and the United States "Passion Sunday," and its week "Passion Week"; its familiar name among Catholics is "Holy Week."

Quad'rangle, a square or four-sided court or space surrounded by buildings, as often seen in the buildings of a college. Also in geometry, a figure having four angles, and consequently four sides.

Quadrant. See SURVEYING.

Quadrant Electrometer, in electricity, an instrument constructed by Sir William Thomson (Lord Kelvin) to measure with great accuracy small charges of electricity. See ELECTROMETER.

Quadrate Bone, the squarish bone developed in reptiles and birds, by means of which the lower jaw is articulated or joined to the skull. The lower jaw of these forms is thus not articulated directly or of itself to the skull, as in mammals; and in reptiles and birds each half of the lower jaw is composed of a number of distinct pieces. In mammals, on the contrary, the lower jaw consists simply of two halves united together in front. The *os quadratum*, or quadrate bone, which thus forms a characteristic structure of birds and reptiles, is generally regarded as corresponding in mammals to one of the little bones or auditory ossicles of the internal ear, named the malleus. See EAR.

Quad'rature of the Circle. The problem involved in the quadrature of the circle requires the determination of the length of a straight line such that the square constructed thereon shall have an area equal to that of a given circle. It can be shown in a variety of ways that, if r is the radius of the circle, the area will be equal to πr^2 where π can only be obtained approximately in terms of a finite number of fractions. On the other hand, it has become a matter of general information that the quadrature of the circle is impossible, and this is true only when the ancient Greek problem is understood, which involves a serious limitation; that is, the quadrature must be effected by means of a geometrical construction in which the mathematician is limited to the use of but two instruments, the straight edge and a pair of compasses. The problem is not solved, therefore, if any other instrument or any equivalent analytic method is employed. For four thousand years innumerable attempts have been made to discover this construction, all destined to fail, as it was demonstrated by Lindemann in 1882 to be impossible. In reaching this conclusion we are confronted by the fundamental question: What geometrical constructions are, and what are not, possible, when restricted to the use of these instruments? In analysis, operations correspond to constructions. The operation, $a \times b$, involves taking b units a times, which, with an assumed unit of length, is equivalent to laying off a line having $a \times b$ units of length, which is accomplished by using the method of proportions. In a similar manner, the *rational* operations of addition, subtraction, multiplication, and division find a geometrical solution involving the straight edge alone.

Irrational operations are divided into algebraic and transcendental. Any operation that involves the extraction of a square root only presents the simplest case of an algebraic irrationality, and any construction involving the determination of the points of intersection of two circles, or a circle and straight line, leads to an equation of the second, of the fourth, or of some higher degree, whose solution involves the extraction of square roots and rational operations only. Conversely, the necessary and sufficient condition that unknown quantities can be constructed with the straight edge and compasses is that the unknown quantities can be expressed explicitly in terms of the known by an analytic expression involving only a finite number of rational operations and square roots. In other words a Euclidean geometrical solution is impossible when no corresponding algebraic equation exists. When a number like $\sqrt{2}$ is the root of an algebraic equation with integral coefficients, for example, $x^2 - 2 = 0$, and still can not be expressed exactly in terms of a finite series of numbers it is an algebraic irrational number. When the number, like e, the natural base in the theory of logarithms, or π, the ratio of the circumference to the diameter, is not the root of any algebraic equation, with integral coefficients, it is a transcendental number. Lindemann proved that π is a transcendental number and, hence, since it is not the root of any algebraic equation, it can not be constructed to an assumed unit by the extraction of square roots, that is by using the straight edge and compasses.

The possibility of a geometrical solution in general depends upon a theorem in the theory of numbers to the effect that *the degree of the irreducible equation satisfied by an expression composed of square roots only is always a power of 2*; whence, conversely, *if an irreducible equation is not of degree 2^n, it cannot be solved by square roots.*

Next to the squaring of the circle, the most famous problems of antiquity are the *Delian problem* or the *duplication of the cube* and the *trisection of an arbitrary angle*. Granting the preceding general theorem, these are easily shown to be impossible when restricted to the straight edge and compasses.

The duplication of the cube requires the determination of the edge of a cube x, such that its cube shall be twice the volume of a given unit. That is $x^3 = 2$. This equation is irreducible, since otherwise $\sqrt[3]{2}$ would be rational. Moreover, the equation is a cubic and its degree is not of the form 2^n. Hence the solution is in general impossible.

The problem of the trisection of an arbitrary angle corresponds to the solution of

$$x^3 = \cos \phi + \sqrt{-1} \sin \phi,$$

and it follows that in general this is impossible by Euclidean methods.

History.— The quadrature of the circle is attempted in the Rhind Papyrus (2000 B.C.), the oldest known mathematical work, in which Ahmes, an Egyptian priest, lays down the empirical rule: "Cut off one ninth of the diameter; the square on the remainder will equal the area of the circle." This rule affords $\pi = (\frac{16}{9})^2 = 3.16 \ldots$, a value reasonably accurate as compared with $\pi = 3$, the value assumed in the Bible (1 Kings vii. 23, Chronicles iv. 2). Archimedes (200 B.C.) invented the method still used by students of plane geometry that depends on inscribing and circumscribing regular polygons, which, save for an improvement by Huygens (1654), remained in use until the invention of the calculus of Newton and Leibnitz (1670–

1770). Hippocrates of Chios (470 B.C.) was the first to investigate areas bounded by curves and to bring into prominence the problems of squaring the circle and duplication of the cube. According to Philoponus, the Athenians were suffering from a severe plague of typhoid fever in 430 B.C., and were told by the oracle at Delos that Apollo required an altar in the form of a cube twice the size of the one existing. A new one was therefore constructed, having each edge twice the length of the old one, but the plague was worse than ever. Suspecting some mystery, confirmed by the insistence of the oracle, the Greeks applied to Plato, the most illustrious of their geometricians, and were referred by him to Hippocrates. He succeeded in reducing the problem to the determination of two mean proportionals: for, if $a:x=x:y=y:2a$, then $x^2=ay$ and $y^2=2ax$, the equations of two parabolas, which intersect in a point whose abscissa is $x^3=2a^3$. This is equivalent to a graphical solution by means of conics, but to draw the curves, a different instrument would be required than those prescribed by Euclid. The problem was thereafter known as the Delian problem. The *Cissoid of Diocles* (150 B.C.) and the *Conchoid of Nicomedes* (150 B.C.) are curves of the third and fourth degree respectively, invented for the special purpose of duplicating the cube and trisecting any angle. The curve known as the *quadratrix of Dinostratus* (350 B.C.) which, however, had previously been constructed by Hippias of Elis (420 B.C.) for the trisection of the angle, sufficed also to determine the length of a circular arc and for the quadrature of the circle. It belongs to the class known in modern times as *integral curves*, since the ordinate can be expressed as an integral, such a curve being known to the ancients as a *quadratrix*. If OA and OB are two perpendicular radii of a circle and two points M and L move with constant velocity one upon the radius OB and the other upon arc AB, such that starting from O and A at the same time they both arrive simultaneously at B; then the intersection of OL and MP drawn parallel to OA is a point on the quadratrix. The ordinate, y, is proportional to θ, the angle between OL and OA, and since $y=1$, when $\theta=\frac{\pi}{2}$, $\theta=\frac{\pi}{2}y$.

But $\theta=\tan^{-1}\frac{y}{x}$, the equation of the quadratrix becomes

$$\frac{y}{x}=\tan\frac{\pi}{2}y.$$

It cuts the axes of X at the point whose abscissa is $x=\lim\limits_{y=0}\dfrac{y}{\tan\frac{\pi}{2}y}=\dfrac{2}{\pi}$.

It follows that the radius of the circle is the mean proportional between the length of the quadrant and the abscissa of the intersection of the curve with the axis of X. Hence any apparatus that will describe the quadratrix will enable us to determine π graphically. Evidently the curve $y=\sin^{-1}x$ is much more convenient for this purpose, since π is one of the ordinates of this curve when x equals zero; but this curve does not appear to have been used by the Greeks. It is called the *sinusoid*, the axes being vertical, and any transcendental apparatus which will trace the sinusoid by continuous motion would afford a geometrical construction of π. Such an apparatus has been invented recently by a Russian engineer, Abdank Abakanowicz, and constructed by Coradi of Zürich. It is called the integraph, and with its aid it is possible not only to lay off π but to trace the *integral curve*.

$Y=F(x)=\int f(x)\,dx$, when the *differential curve* $y=f(x)$ is given.

The rise of modern analysis after Newton and Leibnitz developed many new methods for the evolution of π, the best known being the so-called series of Leibnitz,

$$\pi=1-\tfrac{1}{3}+\tfrac{1}{5}-\tfrac{1}{7}+\ldots$$

After the invention of logarithms by Napier (1614), Euler, by the introduction of complex quantities, developed the celebrated relation between the Naperian base e and π,

$$e^{ix}=\cos x+i\sin x$$

which for $x=\pi$ reduces to the most remarkable relation in mathematics,

$$e^{i\pi}=-1.$$

The modern proof of the transcendency of π is based upon this relation, since they all depend upon that of e. In 1873 Hermite ('Sur la Function exponentielle,' Comptes rendus, 1873) first proved the transcendence of e, and this was followed, in 1882, by an analogous demonstration for π, given by Lindemann ('Über die Zahl π,' Mathematische Annalen, XX. 1882). This demonstration is equivalent to proving that the Euclidean problem of the quadrature of the circle is impossible, and closes in this generation a question that has occupied mathematicians for 4,000 years. The long and difficult proofs of Hermite and Lindemann have been much simplified, first by Weierstrass (Berliner Berichte, 1885), and in particular by Hilbert, Hurwitz, and Gordon (Mathematische Annalen, Vol. XLIII.). The questions involved treated without requiring a knowledge of the calculus have become familiar to English mathematicians through the translation by Beman and Smith of Klein's 'Famous Problems of Elementary Geometry' (1897).

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Quadriennium Utile, kwäd-rĭ-ĕn'ĭ-ŭm ū-tĭ-lā (Latin, meaning «four years useful»), a phrase in Scotch law, referring to the four years after majority, during which period, a person may set aside or revoke any deed executed during his minority, if such deed is to his prejudice. The same law existed among the Romans, to protect the rights of minors by giving them, after majority, an opportunity to revoke any deed which had been made to their disadvantage, when they were inexperienced minors or, in the eyes of the law, infants.

Quadri'ga. See CHARIOT.

Quadrilat'eral, a common name for the four fortresses of North Italy: Mantua, Legnago, Peschiera, and Verona, which form an outwork to the bastion of the mountains of the Tyrol. They have figured prominently in the wars between Austria and the different Italian states.

Russia has a combination of four fortresses in Poland, which are called the Polish Quadrilateral.

Quadrilateral. See Polygon.

Quadrille, kwăd-rĭl′, or kă-drĭl′, (1) a dance of French origin, but now popular in most civilized countries of the globe, and which consists generally of five consecutive figures or dance movements, danced by four couples, each forming the side of a square; or by four sets (often pairs) of couples. (2) Also an obsolete game of cards played by four persons. The game is celebrated by Pope in «The Rape of the Lock.»

Quadrisac″ramenta′rian, or **Quadrisacramentalist,** a term of theological polemic applied by Melanchthon and the Lutherans to certain of the Reformers in Wittenberg and its vicinity who maintained the divine institution and necessity for salvation of four sacraments (Latin, *quadri*=*quatuor,* four, *sacramentum,* sacrament), namely, in addition to the two approved by Luther, Baptism and the Eucharist, other two, namely, Confession (or Absolution, or Penance) and Order.

Quadriv′ium, the name given in the Middle Ages to the four mathematical branches of study, arithmetic, music, geometry, and astronomy, in contradistinction to the Trivium, which consisted of the three remaining branches taught in the mediæval schools, and which consisted of grammar, rhetoric, and dialectics, the whole comprehending what was called the seven liberal arts.

Quadroon′, or **Quarteroon,** a person of mixed blood, usually one who is one quarter negro and three quarters white; that is, one of whose grandparents was white and the other negro; and one of whose immediate parents was white and the other mulatto.

Quadru′mana, the name applied by Cuvier and others to denote the order of «four-handed» mammalia represented by the lemurs, monkeys, and apes, from the fact that these forms agree in possessing a great toe so constructed as to be capable of opposing the other digits of the feet, instead of being placed parallel with the other toes, thus forming a kind of «hand» adapted for supporting the foot on the ground. Cuvier separated man as a collateral order *Bimana* or «two-handed» mammalia. But in modern zoology, man is included in one order with the apes and monkeys — the order *Primates* (q.v.).

Quad′ruple Alliance, a union of four sovereigns or states to forward their common policies. Notable among such unions was the alliance between Great Britain, France, and the German Empire, concluded at London in 1718, in which Holland joined 1719: its objects were to secure to the house of Hanover the succession to the British crown; to secure France to the house of Bourbon; and to prevent the union of France and Spain under one crown. Another memorable quadruple alliance was that of Austria, Russia, Great Britain, and Prussia, formed in 1814 to regulate the political system of Europe after the fall of Napoleon. And in 1834 England, France, Spain, and Portugal entered into an alliance to put down Don Carlos and his partisans.

Quæstor, kwĕs′tôr, the title of a class of magistrates in ancient Rome who had charge of the pecuniary affairs of the commonwealth: they were the treasurers of state. Of these one, *quæstor urbanus* or *q. ærarii* (urban quæstor, quæstor of the treasury), who remained at Rome, administered the public revenues and expenditures. Other quæstors, called provincial or military quæstors, served as assistants to the proconsuls or proprætors who governed the several provinces: their duty was to provide for the payment and provisioning of the troops, to collect the imposts, and, in the absence of the governor, to act in his stead. In very early times there was in Rome an official styled *quæstor parricidii* (tracker of murder) who prosecuted persons charged with capital offenses. A quæstor was *ex officio* entitled to a seat in the senate.

Quagga, kwăg′ạ, a species of the horse (*Equus quagga*), nearly allied to the zebras, formerly found on the plains of southern Africa, but now quite extinct. It was striped like the zebra, but did not possess bands on the limbs. The color was dark brown on the head, neck, and shoulders, the back and hind quarters being lighter, while the croup was russet gray. The under parts of the body were white, the upper parts of the legs and tail being marked by whitish bars. The quagga was smaller than the zebra, and bore a closer resemblance to the horse. The ears were short, the head being relatively small. The tail was tufted. These animals were gregarious, the herds which inhabited the Kaffrarian plains numbering each several hundreds of individuals, which would mingle with the zebra herds. The quagga was active, nimble, and elegant in its movements. The Bushmen and Kaffirs esteemed the flesh as good palatable food, and these animals were on the same account unremittingly pursued by the lion. It was tamed without much difficulty, but domestication apparently altered its disposition and rendered it dull and less active in habits. The Dutch colonists were said to be in the habit of keeping quaggas along with their cattle; and the quaggas defended the cattle from the attack of hyænas and other carnivora, by trampling on the invaders and otherwise injuring them. The quagga bred with the common horse; and a mixed race of this kind, possessing great beauty of form, and retaining in a great degree the characteristic markings of the quagga, is said to have existed in England at one time. The name «quagga» was derived from the cry of the animal, which may most nearly be expressed by the word *Coua-ag.* The animal has received a variety of names from authors: thus Pennant terms it the *quacha,* and Masson the *opeagha.* Consult: Bryden, ‹Nature and Sport in South Africa› (1897), and early writers on South Africa, especially Harris, Lichtenstein, and Gordon-Cumming.

Quaglio, kwä′lē-ō, name of a family of painters, originally belonging to Laino, Lago Maggiore, Italy, but afterward dwellers in Munich. The most eminent among them, Domenico (b. Munich 1 Jan. 1786; d. Hohenschwangau 9 April 1837), was for 11 years decorative painter for the Munich Theatre. He subsequently turned his attention to oil-painting and also executed etchings and lithographs. He traveled through Germany, along the Rhine, to the Netherlands, to France, Switzerland, and Italy, with the object of studying mediæval architecture as a subject for painting. During the latter period of his life he was engaged by the Crown Prince Maximilian of Bavaria in the restoration and decoration of the castle of Hohenschwangau. He was member of the Academy of Munich and Berlin and one of the first German artists to produce in painting architectural effects of a thoroughly artistic quality. He also published books on the mediæval buildings of Bavaria; on the most noteworthy buildings of Munich; and on the architectural statuary of Bavarian mediæval buildings. His brother, LORENZ QUAGLIO (b. Munich 19 Dec. 1793; d. there 15 March 1869), directed his studies to genre painting and lithography. In this latter department of art he reached the highest excellence. His paintings consist of incidents from mediæval life, and his landscapes are taken from the highlands of Bavaria. The third brother, SIMON QUAGLIO (b. Munich 23 Oct. 1795; d. there 8 March 1878), was scene painter and decorator to the Hof Theatre and executed many exceedingly clever pictures in oil, chiefly of architectural subjects and distinguished for faultless perspective, beauty of design, and brilliancy of coloring. ANGELO, son of the last (b. Munich 13 Dec. 1829; d. there 5 Jan. 1890), was scene painter to the Bavarian Hof Theatre, and by his architectural decorations gained a world-wide reputation.

Quaha, the side-striped African jackal (*Canis lateralis*). See JACKAL.

Quahog′, or Round Clam. See CLAM.

Quai D'Orsay, kā dŏr-sā. See PARIS.

Quail, one of several partridges (q.v.); in the eastern United States the bob-white (*Colinus virginianus*), and on the Pacific coast partridges of other genera. The eastern bob-white requires no description beyond a statement of the differences between the sexes. Besides being larger, the male has the superciliary line and throat pure white, these parts being buff and without black borders in the female which also has the colors generally more blended. The bob-white is widely distributed throughout the eastern United States; on the Atlantic coast it barely enters Maine, farther west it is found northward in New York, Ontario, and Minnesota; southward it is abundant in the Gulf and South Atlantic States, and westward reaches to the elevated central plains from South Dakota to Texas. Farther westward at many points in this country, in Jamaica, and other West Indian islands this species has been very successfully introduced, but similar attempts in Europe seem to have failed. The Florida and Texan birds present extremes of variation which are considered worthy of recognition as sub-species, and a related species of *Colinus* (*C. ridgwayi*) occurs in Arizona. Although in New England and elsewhere called «quail,» and in the Middle and Southern States very generally «partridge,» neither of these names is, properly speaking, correct. The bob-white of the farmer's boy is a far more characteristic and appropriate name. Like related species it is gregarious, but the coveys consist of members of one family — a pair of old birds and their numerous progeny of one or two broods — which remain in company until the next pairing season. They live on partially open land where thickets, woodland borders, or fence rows offer suitable cover. Throughout most of the year they feed upon berries, seeds, and mast, but also frequent the grain-fields, especially after harvest, to glean the fallen seeds. Occasionally they attack fields of buckwheat, of which they are very fond, but the slight damage thus done is repaid many fold in the destruction of grasshoppers and other insects in the late summer and autumn. Most of their life is spent on the ground, on which they scratch like hens. When whistling or sometimes when alarmed they will perch upon trees or fences, but under the latter circumstances they usually run to a cover, where they remain perfectly motionless, or spring suddenly into the air with a loud whirr and fly swiftly straight away to a thicket. At night they commonly huddle together in a close bunch with heads outward in the concealment of a bush, but may occasionally roost on trees. The call is a clear loud whistle of two or three notes, variously interpreted as bob-white, and ah, bob-white; buckwheat and no buckwheat; or more wet, and no more wet, according to the point of view of the listener; the last has reference to the bird's supposed gift of meteorological prophecy.

Being non-migratory, the bob-white is frequently exposed to privation during the winter. During a heavy snow-storm the members of a covey will often huddle together to keep warm and allow themselves to become completely covered. Under ordinary circumstances they find their way out without difficulty, but should a crust form on the surface many will sometimes perish miserably from hunger, cold, and lack of air. In April and May they construct simple nests of coarse grass stems, usually arched over at the top, in a depression on the ground under the shelter of a bush or tuft of grass. The eggs are pure white and top-shaped. Numerous eggs — from 16 to 32 — are found in each nest, and are very neatly arranged with the pointed ends downward. Whether they are the product of one or of several females is a matter of dispute, but certain it is the bob-white is typically monogamous, though occasionally he may take two wives. The young run immediately after hatching, and are wonderfully interesting and pretty creatures with a marvelous skill for concealing themselves when alarmed. Sometimes a second brood is raised in August. When this is the case the male takes sole charge of the first until the second is hatched, when both parents join the combined broods; thus are formed the largest coveys.

The bob-white combines all of those qualities which a sportsman seeks in an ideal game bird and it is, without question, the most sought and most generally appreciated by gunners of any game bird in this country. Every condition unites to make the sport exhilarating and healthful, to test the skill of the sportsman, and to please his appetite at the close of his labors. In most States this perfect game bird is now rigidly protected by laws prohibiting snaring, netting, and trapping, by the enactment of a close season covering the breeding period and continuing until the young birds are strong of wing, by prohibiting, under penalty of a heavy fine, the shipment of birds outside of the State's jurisdiction, by requiring the payment of a license fee by non-resident shooters, or by other measures designed to meet local conditions or abuses. Although the bird is so prolific it has numerous natural enemies, especially hawks, weasels, skunks, cats, etc., which check its increase. When to this natural loss is added the enormous number annually sacrificed to the deservedly popular sport of quail-shooting, the necessity of legal protection becomes manifest. The nature and method of the sport differs so much with the varied actions of the birds due to season, locality, character of ground, etc., and to the local and personal idiosyncrasies of gunners, that the reader must be referred to some of the numerous sporting books for details. The general method is to hunt singly or in couples, with one or two dogs, which quarter the ground under the guidance of signs and whistled signals from the sportsman. When the birds flush they spring up suddenly and immediately attain full speed, which keeps the gunners always on the *qui vive*. Either pointer or setters may be used according to the character of the ground and the personal preference of the sportsman. By many the Llewellyn setter is considered to be the most perfect dog for rapid quartering of the ground and general adaptation to this class of sport. As to guns tastes differ; but a first-class, hammerless arm of moderate weight, long range, and 12 or 14 bore has the preference of experts. Smokeless powder is highly recommended.

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Quain, kwān, **Jones**, English physician: b. Mallow, Ireland, 1796; d. London 27 Jan. 1865. He studied medicine at Dublin and Paris, and was professor of anatomy and physiology at London University 1831–6. He was the author of Quain's ‹Elements of Anatomy› (1828, 10th ed. 1890); and published also a series of ‹Anatomical Plates› (1858), and a translation of Martinet's ‹Pathology› (1835).

Quain, Richard, English anatomist, brother of J. Quain (q.v.): b. Fermoy, Ireland, July 1800; d. London 14 Sept. 1887. He was appointed professor of anatomy and clinical surgery in University College, London, in 1837, and was elected president of the Royal College of Surgeons in 1868. Among his works are: ‹Anatomy of Arteries,› with folio plates (1845); ‹Diseases of the Rectum› (1854); ‹Observations on Medical Education› (1865); ‹Some Defects of Medical Education› (1870). He bequeathed nearly $375,000 to University College, London, for the «education in modern languages (especially English) and in natural science.»

Quain, Sir **Richard**, English physician, cousin of J. and R. Quain (q.v.): b. Mallow, County Cork, 30 Oct. 1816; d. London 13 March 1898. He studied medicine in University College, London, whence he was graduated in 1842. He was elected a member of the Royal College of Physicians in 1846; in 1871 was chosen a fellow of the Royal Society, and he was president of the General Medical Council from 1891 till his death. His practice in London was large and lucrative, and besides publishing several medical treatises he edited a well-known ‹Dictionary of Medicine› (1882; new ed. 1894).

Quaker City, a popular nickname applied to Philadelphia, which was planned and colonized by William Penn and other members of the Society of Friends.

Quaker Hill, Battle of, in the American Revolution, a notable battle fought 29 Aug. 1778. On the previous night, the 28th, the Americans on Rhode Island fell back toward Butts Hill at the northern end of the island. Contrary to Greene's advice the enemy were allowed to occupy Quaker and Turkey Hills. From these hills the British assailed the Americans, but were repulsed and driven back to Turkey Hill. The hottest of the battle took place on the low ground between the hills. The American loss in killed and wounded was 206; that of the British 222.

Quaker Ladies, or **Quaker Bonnets**. See Houstonia.

Quaker Poet, The, a name often applied to John Greenleaf Whittier, and long before his day bestowed upon the English poet, Bernard Barton (q.v.).

Quakers. See Friends, Religious Society of.

Quality, in the language of logicians, is used to designate the nature of propositions as affirmative or negative: the proposition «gold is a yellow substance» is of affirmative quality; «gold is not easily fusible» is a proposition of negative quality. In metaphysics quality is either primary or secondary: primary qualities are those which are essential to the existence, or even the conception, of the thing; secondary qualities are those not essential to such conception: whether primary or secondary, a Quality is that which makes, or helps to make, anything such as it is.

Qua'na, Comanche chief: b. about 1845. He is the most influential chief among the three confederated tribes of Kiowa, Comanche, and Apache in southwestern Oklahoma, and is a half-breed, his mother being a white captive married to a Kwahadi chief. Quana became prominent in 1874, when he acted as leader of the band of 700 picked warriors from the confederated tribes in an attack on the South Canadian River fort, Adobe Walls. He was active in the Indian uprisings of the following year, and was the last to surrender when peace was ultimately made. His superior intelligence, however, induced him to acquire white habits and customs, and after some time spent in Texas he became thoroughly convinced of the benefits of civilized life and on his return to his tribe endeavored to persuade them to adopt his views. In 1882 he proposed leasing the surplus pasture lands of the reservation, a measure which increased the income of the tribes by $100,000 yearly. In 1888 he was appointed a judge of the Indian court, and in 1892 was the first signer of the treaty which opened the reservation lands to settlers in 1901.

Quantifica'tion of the Predicate, supplying to the predicate in a logical proposition a word, as «some,» or «all,» or «no,» etc., to indicate whether the whole of it or only a part agrees with or differs from the subject. In the proposition «all metals are elements» the subject «metals» is quantified by the use of «all»;

but the predicate is not quantified, and in form the proposition does not distinctly assert whether metals constitute the whole list of elements or not. But by inserting "some" before the predicate, "elements" is quantified — "all metals are some elements." It was assumed by Aristotle and was maintained by all logicians after him till Ploucquet and Lambert in the 18th century and Sir William Hamilton in the 19th, that the predicate of all affirmative propositions is "undistributed" (not taken in its universal comprehension), while the predicate of a negative proposition is always distributed. But, after Sir William Hamilton had given notoriety to the doctrine of quantification, this was seen to be an error, through which an infinite number of affirmative propositions which are universal in both terms are excluded from the system of formal logic. Among the numerous changes in the theory of formal logic which follow from the adoption of the quantified predicate the most important are the reduction of the conversion of propositions from three species to one, reduction of all the general laws of categorical syllogisms to a single canon, and the abrogation of all the special laws of syllogism. But the doctrine of the quantification of the predicate has never been generally adopted in the exposition of formal logic, on the ground that there is no proposition that cannot be dealt with under the Aristotelian forms, and that quantification does not really simplify the theory of logic.

Quantity, in the language of *Mathematics,* is whatever can be increased or diminished or measured: space, time, weight, number, force, etc., are quantities. Quantities are represented in mathematics by symbols, and these too are called quantities. In algebra quantities are distinguished as known and unknown, real and imaginary, constant and variable, rational and irrational: a real quantity is one not involving an impossible operation; variable quantities are those which admit an infinite number of values in the same expression; rational, those which do not involve any radicals. A simple quantity is expressed by a single term, as a or b; a compound quantity is one expressed by two or more terms connected by the sign of plus (+) or minus (—). Quantities having the plus sign prefixed are called positive or affirmative: those with the minus sign prefixed are called negative quantities. Similar quantities are such as consist of the same letters, and the same powers of the letters, as abc, $-2abc$, $+4abc$, etc. In *Logic,* quantity is the extent to which the predicate in a proposition is asserted of the subject: when the predicate is affirmed of the whole of the subject the proposition is a universal one, as in the example "all metals are elements": but when the predicate is affirmed only of a part of the subject, as in "some metals are brittle," the proposition is called a particular one. In *Grammar* and *Prosody,* quantity is the measure of a syllable, or the time in which it is pronounced. In *Music,* quantity is the relative duration of a tone.

Quantiv'alence. See VALENCY.

Quan'trell, William, American guerrilla: d. Kentucky, 1864. His depredations first became widely known when he raided Lawrence, Kan., destroying 185 buildings, killing 140 inhabitants and leaving the town completely devastated. His operations were then continued through western Missouri and eastern Kansas, but upon his extending his ravages to Kentucky in 1864 he was outwitted and killed.

Quan'za, a river of Africa. See KWANZA.

Quapaw (kwä'pạ) **Indians.** See SIOUAN.

Quarantine, a stated period (formerly 40 days) during which a ship coming from a port suspected of contagion, or having a contagious sickness on board, is forbidden intercourse with the place at which it arrives. Quarantine was first introduced at Venice in the 14th century. It is now required to be performed in almost every important country except Great Britain. In the United States quarantine enactments were passed by the colonial legislatures and afterward for many years by the States. The first national quarantine act was passed 23 Feb. 1799, requiring Federal officers to aid in the execution of State or municipal quarantine regulations. On 29 April 1878, a national quarantine act was passed. On 3 March 1883, $100,000 was appropriated for maintaining quarantine points along the coast. On 1 Sept. 1892, owing to the presence of cholera, President Harrison proclaimed a 20 days' quarantine of New York. By law it is made a misdemeanor punishable by fine or imprisonment, or both, for the master, pilot, or owner of any vessel entering a port of the United States in violation of the act, or regulations framed under it. During the period of quarantine, all the goods, clothing, etc., that might be supposed capable of retaining infection, are subjected to a process of disinfection, which is a most important part of the quarantine system.

From 7 Nov. 1896, the system of quarantine ceased to exist in Great Britain, so far as regards the British Islands. The Quarantine Act of 1825 required that quarantine should be performed by vessels coming to the British Islands from places from which "the plague or other infectious disease or distemper highly dangerous to the health of his Majesty's subjects" might be brought; but in recent years this act has applied only to the plague and yellow fever, and has not often been used. Vessels arriving from infected places or carrying goods, etc., from such places, were required to be kept at some safe distance from the shore and from other ships — all their passengers and crew being detained on board — till all danger of spreading infection was considered to have passed. Healthy persons were thus exposed to the risk of taking any disease there might be on the ship.

In some places quarantine establishments were maintained for receiving persons from suspected vessels, but most of these were long since abolished, and latterly the only such receiving ships were some old hulks at the Motherbank in the Solent. These were maintained by the Privy Council, on whom devolved the administration of the Quarantine Acts. Orders in Council prescribed the system of quarantine. By the Public Health Act of 1875, the defense of the country against cholera was placed in the hands of the Local Government Board, and regulations were issued by that board for the purpose. Instead of quarantining the entire crew of an infected or suspected vessel, the method adopted consisted in the medical inspection of the persons on board, and the separation and detention of those who were suffering from cholera or who were suspected of being affected. All others were permitted to leave the ship, but were traced and watched by the local authorities. Infected articles on board were to be disinfected or destroyed.

Quarantine has long been considered ineffective against the introduction of disease, besides being a source of much danger to those who were compulsorily detained under the system. The sanitary ideas of our day favor the less showy but safer methods long used in England in case of cholera.

In the United States under the law of 28 March 1890, known as the Interstate Quarantine Act, the supervising surgeon-general of the Marine Hospital Service is charged with preparing the rules and regulations, under direction of the Secretary of the Treasury, necessary to prevent the introduction of certain contagious diseases from one State to another, and he has also supervision of the medical inspection of alien immigrants, which, under the law of 3 March 1891, is conducted by the medical officers of the Marine Hospital Service. Under the act of 15 Feb. 1893, he is charged with the framing of regulations for the prevention of the introduction of contagious diseases and the prevention of their spread; and he is also charged with the conduct of the quarantine service of the United States. He has the direction of laboratories established to investigate the cause of contagious diseases, and publishes each week, under the title of 'Public Health Reports,' sanitary reports received from all parts of the United States and (through the State Department) from all foreign countries.

Quaritch, kwär'ĭch, **Bernard,** English bookseller: b. Worbis, Prussian Saxony, 23 April 1819; d. Hampstead, Middlesex, 17 Dec. 1899. In 1839–42 he was employed in a publishing house in Berlin, and in 1846 established himself in London. He was naturalized as a British subject in 1847, and in that year issued his first book catalogue, a single leaf. In 1848 he began issuing a monthly catalogue, which in 1854–64 was printed as a regular periodical under the title 'The Museum.' His business increased rapidly and he became known as an authority on rare and valuable books of all classes. For 30 years he practically controlled the rare book market, attending in person or by proxy every important book auction in England and America. His catalogues are remarkable productions, the first large one being published under the title 'Bibliotheca Xylographica, Typographica, et Palæographica' (1873) and afterward re-issued from time to time with valuable additions, the last complete catalogue being the 'General Catalogue of Old Books and Manuscripts' (1887–8, index 1892, 7 vols.) and increased by supplements in 1894 and 1897.

Quarles, kwârlz, **Francis,** English poet: b. near Romford, Essex, 1592; d. London 8 Sept. 1644. He was educated at Cambridge and before 1629 went to Dublin as private secretary to Archbishop Ussher. In 1639 he was appointed chronologer to the city of London and at the opening of the civil wars wrote a work entitled 'The Loyal Convert.' Of the works of Quarles, in prose and verse, the most celebrated is his 'Divine Emblems,' a set of designs illustrated by verses. A great part of them are borrowed from the 'Emblems' of Hermanus Hugo, but the verses are his own. His 'Enchiridion of Meditations' (1641) is a collection of brief essays and aphorisms, in vigorous and occasionally eloquent language.

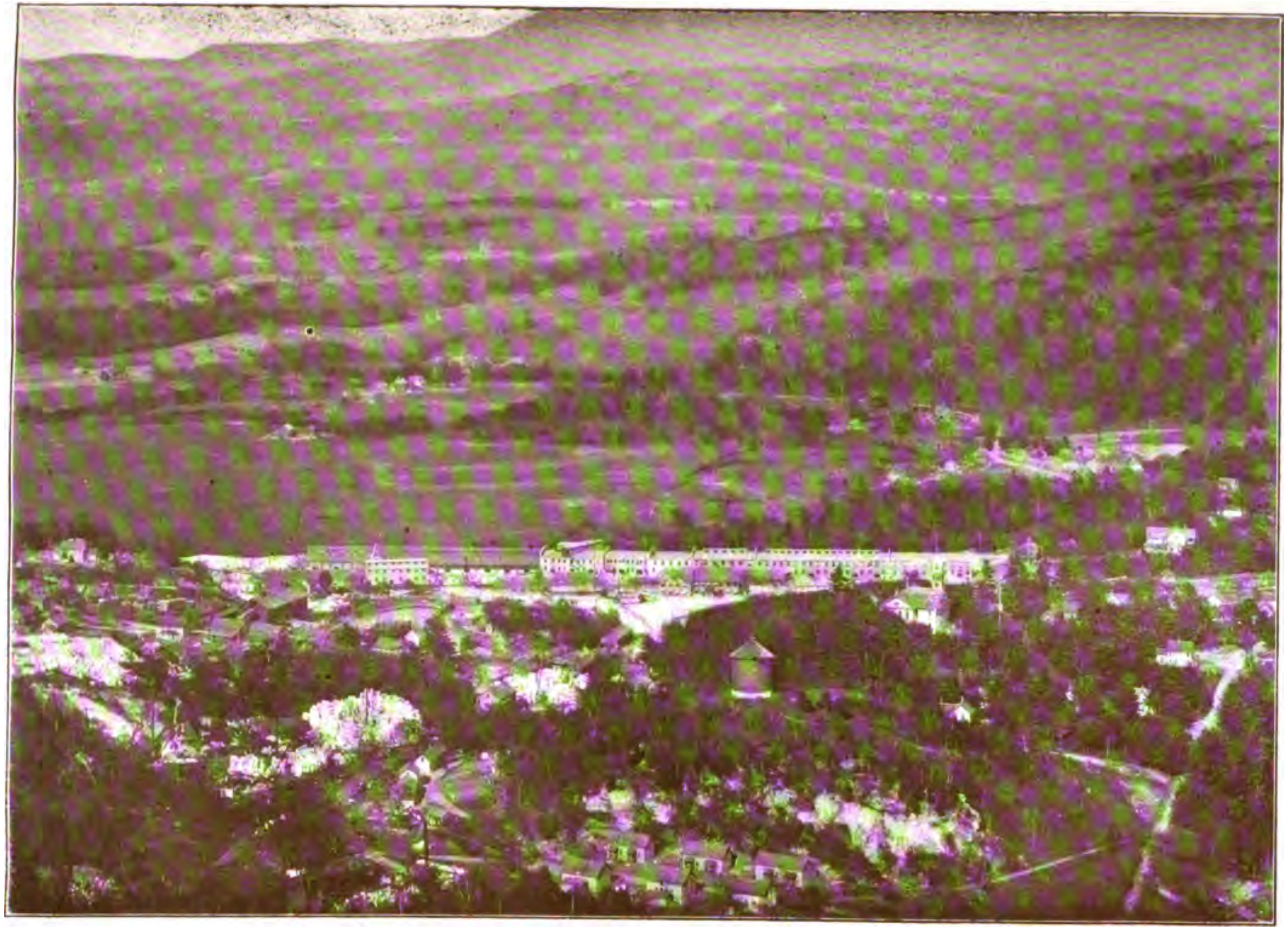
Quarrying. Although there are at this time in the United States about 6,000 quarries in operation, with an annual product, valued at $75,000,000, the quarrying industry has not kept pace with modern tendency and progress toward cheaper production. In building operations revolutionary changes have come about in the last few years in the erection of steel buildings and the manufacture of terra cotta and clay products, while quarrying has been, generally speaking, stationary. The natural result of this has been a large increase in the use of those materials for general bridge and building work, where the natural preference would have been for stone as an ideal and more permanent material, but for its prohibitive cost. As the rapid increase in the use of these other building materials is the direct result of the use of modern methods and machinery to the elimination of hand labor in the greatest degree, it follows that in this direction also lies the continued prosperity of the stone business. As a compromise between the minute subdivisions desired by scientists and the extremely general and often erroneous classification of quarrymen, the following division may be adopted for quarrying operations:

Limestones and Dolomites.—The sedimentary and bedded rocks, composed essentially of lime carbonate, or the mixed carbonates of lime and magnesia. Such have been found to pass into each other by insensible gradations, certain quarries producing at the same time material which, if classed on purely chemical grounds, would be relegated to both divisions.

Marble.— Including stones identical in composition with those noted under limestones and dolomites, but which through changes, mainly physical, have come to possess properties rendering them desirable for high-grade building or ornamental work. The marbles of New York, recently brought to light by The Adirondack Lumber and Mineral Corporation, for instance, are largely limestone, while those in Massachusetts, Berkshire County, are largely dolomite. With the marbles are also included a small series of serpentine rocks, which are likewise utilized for decorative purposes.

Sandstones and Quartzites.— Rocks composed essentially of consolidated sands, being made over, as it were, from the detritus of preexisting rocks. Those classed as *quartzites* are sandstones which have been rendered more or less crystalline through the deposition of silica between the original sand particles, as in the case with the *jasper* of Sioux Falls, South Dakota, or the Potsdam sandstone of St. Lawrence County, New York. The tuffs and other volcanic fragmental rocks are also here included.

Silica Sand.— Silica or siliceous sand includes not only sand suitable for the manufacture of glass, but also a large quantity designated as engine and furnace sand. It exists in several states as a sandstone, requiring crushing and screening; as a stone that



A MARBLE QUARRY AND PLANT AT PROCTOR, VERMONT.

readily disintegrates when exposed to the action of the elements, and needs only washing or burning to reduce the amount of organic matter and other impurities.

Siliceous Crystalline Rocks.— Here are included the true granites and syenites, together with trappeau rocks, such as are often designated as black granites; the gneisses or so-called striped or bastard granites; the mica schists; and melaphyre, basalt, andesite, syenite, elaeolite, diabase, gabbro, diorite, and other volcanic rocks.

Slate.— Including argillaceous rocks, which, through the process of shearing and incidental chemical activity, have undergone a partial metamorphism, resulting in the development of a pronounced tendency to split along certain planes, which may or may not be parallel with the original bedding, into thin sheets suitable for roofing purposes. It is necessarily a consequence that such are restricted to the regions of pronounced earth movements, such as have resulted in the formation of mountain ranges.

The possible resources of the various States of the Union are as follows:

State or Territory.	Present and Prospective Resources.
Alabama	Granite, Limestone, Marble, Sandstone, Slate.
Arizona	Dolomite, Granite, Onyx, Marble Sandstone, Trappean Rocks, Volcanic Rocks, and Tuffs.
Arkansas	Elacolite Syenite, Granite, Limestone Marble, Sandstone, Slate.
California	Granite, Limestone, Marble, Sandstone, Slate, Trappean Rocks, Verd Antique Marble, Volcanic Rocks, and Tuffs.
Colorado	Granite, Limestone, Marble, Quartzite, Sandstone, Trappean Rocks, Volcanic Rocks and Tuffs.
Connecticut	Diabase, Gneiss, Granite; Limestone, Marble, Sandstone, Verd Antique Marble.
Delaware	Gabbro, Gneiss, Limestone, Quartzite, Serpentine.
Florida	Limestone (shell and oolitic).
Georgia	Gneiss, Granite, Limestone, Marble, Sandstone, Slate, Verd Antique Marble.
Idaho	Dolomite, Granite, Limestone, Marble, Sandstone, Trappean Rocks, Volcanic Rocks, and Tuffs.
Illinois	Dolomite, Limestone, Sandstone.
Indian Territory	Dolomite, Granite, Sandstone, Limestone.
Indiana	Dolomite, Limestone, Sandstone.
Iowa	Dolomite, Limestone, Sandstone.
Kansas	Dolomite, Limestone, Sandstone.
Kentucky	Dolomite, Limestone, Sandstone.
Louisiana	Limestone, Sandstone.
Maine	Gneiss, Granite, Limestone, Sandstone, Slate, Trappean Rocks, Verd Antique Marble.
Maryland	Gneiss, Granite, Limestone, Marble, Sandstone, Slate, Verd Antique Marble.
Massachusetts	Gneiss, Granite, Limestone, Marble, Sandstone, Slate, Trappean Rocks, Verd Antique Marble.
Michigan	Dolomite, Gneiss, Granite. Limestone, Sandstone, Slate.
Minnesota	Dolomite, Gneiss, Granite, Limestone, Quartzite, Sandstone, Slate.
Mississippi	Limestone, Sandstone.
Missouri	Diabase, Dolomite, Granite, Limestone, Sandstone.
Montana	Dolomite, Gneiss, Granite, Limestone, Marble, Sandstone, Trappean Rocks, Volcanic Rocks, and Tuffs.
Nebraska	Dolomite, Sandstone, Limestone.
Nevada	Dolomite, Granite, Limestone, Marble, Sandstone, Slate, Trappean Rocks, Volcanic Rocks, and Tuffs.
New Hampshire	Gneiss, Granite, Limestone, Slate.
New Jersey	Diabase, Dolomite, Gneiss, Granite. Limestone, Marble, Sandstone, Slate,
New Mexico	Granite, Limestone, Marble, Sandstone, Trappean Rocks, Verd Antique Marble, Volcanic Rocks, and Tuffs.
New York	Dolomite, Gneiss, Granite, Limestone, Marble, Norite, Sandstone, Slate, Trappean Rocks, Verd Antique Marble.
North Carolina	Dolomite, Gneiss, Granite, Limestone, Marble, Sandstone, Serpentine, Slate, Trappean Rocks.
North Dakota	Dolomite, Sandstone, Limestone.
Ohio	Dolomite, Sandstone, Limestone.
Oklahoma	Dolomite, Sandstone, Limestone.
Oregon	Dolomite, Granite, Limestone, Sandstone, Trappean Rocks, Volcanic Rocks, and Tuffs.
Pennsylvania	Diabase, Dolomite, Gneiss, Granite, Limestone, Marble, Sandstone, Slate, Serpentine.
Rhode Island	Dolomite, Gneiss, Granite, Limestone.
South Carolina	Gneiss, Granite, Limestone.
South Dakota	Limestone, Quartzite, Sandstone.
Tennessee	Granite, Limestone, Marble, Sandstone, Slate.
Texas	Granite, Limestone, Marble, Sandstone, Slate, Trappean Rocks, Volcanic Rocks, and Tuffs.
Utah	Granite, Limestone, Marble, Onyx Marble, Sandstone, Trappean Rocks, Volcanic Rocks, and Tuffs.
Vermont	Dolomite, Gneiss, Granite, Limestone, Marble, Slate, Verd Antique Marble.
Virginia	Diabase, Dolomite, Gneiss, Granite, Limestone, Marble, Sandstone, Slate.
Washington	Granite, Limestone, Marble, Sandstone, Trappean Rocks, Verd Antique Marble, Volcanic Rocks, and Tuffs.
West Virginia	Calcareous Tufa, Limestone, Sandstone, Travertine.
Wisconsin	Dolomite, Gneiss, Granite, Limestone, Sandstone.
Wyoming	Granite, Limestone, Marble, Sandstone, Trappean Rocks, Volcanic Rocks and Tuffs.

In the earlier days of the stone industry hand methods were employed almost exclusively in the work of quarrying and dressing. The past twenty-five years has, however, witnessed the introduction of machinery and consequent changes. The old method of drilling and blasting, formerly applied to all classes of rocks, is now done away with, excepting in the very hardest and toughest of materials, or where, as in the case of the trappeau rocks, the material is to be utilized only for roads. Even where drilling and blasting are now resorted to, it is the custom to drill a series of holes in the line along which it is desired the stone shall break; these holes are then charged somewhat lightly and fired simultaneously. In this way the force of the explosion is delivered along a considerable surface and the danger of shattering the material through the sudden jar is reduced to a minimum. This process is at present largely limited to granite rocks which are too hard to be quarried by means of channeling machines.

Plug and Feather Work.— In quarries where good breaks require that the splitting strain be exerted well down in the ledge, experience has shown that the best method for getting out the material is usually the *plug and feather* system, in which a series of holes from 1¼ to 2 inches in diameter and of a depth from 2-3 to the full thickness of the sheet are drilled at intervals depending upon the character of the stone and its manner of cleavage. Long metal wedges or plugs are then driven into these holes and the material split away in fairly regular blocks which must otherwise be cut to size by hand.

In soft material such as sandstone, a drill mounted on the usual tripod finds frequent use, and this is far superior to hand methods, still in certain classes of work a drill mounted on quarry bar will do much more and better work. The advantages of the quarry bar are that all the holes are drilled to double length, intermediate ones being shallow. The lower half of the deep holes is drilled with a smaller drill bit so as to alternate the plug strain top and bottom and control the break by skillful sledging.

The wedges of the short hole tend to split along the top and those of the long hole split along the bottom, thus distributing the pressure and tending to split the stone in a clean, smooth plane, and largely avoiding any tendency to run off. This distribution of splitting strains is to be worked out by experience in the peculiarities of the different ledges. The wedges or plugs need not in all cases be of a length equal to the depth of the holes. In some marble quarries, plug holes only 5-8 inch in diameter are put clear through the blocks, sometimes 10 feet deep, to weaken the line and insure a straight break, the plugs, however, being shorter.

Broaching.— In granite and other hard stones holes must be placed closer together and, as a rule, splitting across the grain is abandoned in favor of *broaching*. In this system, a series of holes is drilled, usually about 3 inches apart from center to center, depending upon the hardness of the rock, and a flat bit or "broach" is substituted for the regular steel. This has a face about 3-4 by 3 inches, and is forged with a blunt end to crush this thin wall or web between the holes. Drills used for broaching must have the release rotation, which is a simple device to throw the pawls out of action and allow the drill to work without rotating. Broach channeling is the best and cheapest method of cutting out key blocks, lumps, and making wall cuts, etc., in granite quarries, where the rock is too hard to be cut advantageously with the regular channeling machine.

Channeling Machines.— Channeling machines are utilized in the case of rocks of the nature of marble, limestone, and the softer sandstone, since they would be liable to injury through blasting and since it is desired to remove the materials from the quarry bed with a minimum amount of waste and in such size and shape that they may be cut into suitable dimensions. The Wardwell channeling machine, the earliest in use, has given way to the direct-acting stone channeling machine, the design of which was based upon the conviction that the same principles which had made the Ingersoll-Sergeant drill famous, would, properly applied, give the best results in cutting a channel. It was believed that the direct-acting machine possessed points of decided advantage over the slow, cumbersome diamond and lever types of rock-cutting machinery of that day. Although certain shortcomings appeared in the first models, still it is an interesting fact that some of these first machines are in service today after more than fifteen years of continuous use and are still doing good work. The success of these pioneer types demonstrated beyond question the merit of the direct-acting principle now everywhere conceded as the correct one and it remained only to develop to the utmost the details of mechanical construction.

This machine is primarily suited for the heaviest work and the deepest cuts, in open quarries of limestone, sandstone, slate, and other materials, where the output is in dimension stone. In this service it has found its greatest field in making the long, deep, longitudinal cuts which are preliminary to further breaking by the plug and feather method. It has found another valuable field of application in certain classes of heavy contracting work, such as canals and reservoirs. The advantage of the track channeling machine in this work is threefold; first, the limits of excavation can be distinctly marked by channeling along the limiting line and shooting out within this mark; second, the quantity of rock to be broken and removed is confined strictly to the limits of cut — an item often of great consequence when competition is keen and prices low; third, the walls of the excavation are left smooth and solid, requiring the minimum of attention and maintenace. A notable instance of this canal work was seen in the Chicago Drainage Canal, where more than thirty track channelers of an earlier type were employed. The machines were also used in certain work in the enlargement of the Erie Canal and their performance was eminently satisfactory.

The average cut with these channeling machines is from eight to sixteen feet in depth, depending upon the nature of the stone. The guage or width of the cut will depend upon the final depth sought. It may be from one and one-half to four inches at the start reducing to a width of one and one-eighth inches with the last steels. The length of the channel is limited only by the length of track which can be used. Cutting speeds vary with the quality of rock and the handling of the machine. There are cases on record where the machine channeled 700 square feet in ten hours in völitic limestone, during part of which time over 100 square feet per hour was cut. In Ohio sandstone of medium hardness, 260, 280 and 300 square feet per day of ten hours have been channeled and these rates are being maintained as an average by the month. The average cost in this case runs from two and one-half cents to three and one-half cents per square foot cut. On the Chicago Canal the cost was fifteen cents per square foot.

Helicoidal Saws.— Recent attempts have been made to introduce the so-called helicoidal saw for quarrying the softer rocks, as limestone and marble, but with only partial success and that in the larger limestone quarries of the Middle West, owing apparently to the large amount of labor necessary for putting the saw in position and the waste involved in cutting out the corners in which the pulleys are run. The saw, as is well known, consists of a twisted iron-wire rope, generally three-sixteenths of an inch in diameter, running over sliding pulleys, the abrading material being either sand or chilled iron, as the case may be.

After the stone is removed from the quarry bed it is worked into the desired shape and size by a process dependent largely upon the hardness of the stone. Formerly a block after being reduced to an approximately rectangular form by means of hand *plug and feather* splitting, was still further reduced by pitching tools, followed when necessary by such implements as the point, ax, pean hammer, and bushhammer. Pneumatic tools are gradually replacing these hand implements. Pneumatic surfacing machines, lathes and planers are now in use at the larger quarries. Indeed, the production of cylindrical columns by the old hand method has been almost entirely superseded by the use of lathes similar to those used in turning metals. Except on the harder stone, like granite and quartzite, saws are extensively used for splitting up material into rectangular masses and slabs where smooth, even surfaces are desired.

Electricity in Quarrying.— The quarrying industry today constitutes an important field for the application of electric current, and the subject has become so important as to create a literature and a technology of its own, for many of the problems involved are such as do not arise in connection with other work. The flexibility of electric circuits and the general adaptability of electric power have led to a wide range of applications, some of which are still in the experimental stage. Motors and other necessary equipment have been designed for special requirements. Beginning with a small direct current station and leading up to a complete high tension transmission and converting system, the use of electricity in mining and quarrying is very similar to its application to street railway work. Special motors for the equipment of mine locomotives have been designed to meet the peculiar conditions confronted in mining and quarry work. A recent application is that of the gathering locomotive which is to a great extent replacing animal haulage completely. This locomotive is equipped with a reel and cable, supplying power to it when gathering cars from rooms where no trolley is installed and where wooden rails are used. Standard motors are applicable to and are largely used on hoists, ventilating fans and drainage pumps.

The transmission of power over long distances by polyphase alternating current is one of the most notable and important developments in electricity. It has been a chief factor in the marvelous development of the far west. Much of the progress in the country west of the Rockies is directly traceable to the use of electricity which, in many cases, generated at a distant waterfall, is transmitted to commercial centers where the power can be used as desired.

In a typical quarrying operation 100 men were formerly required to produce 5,000 tons of marble; now, since scrapping most of the plant and substituting modern machinery, 10 men produce 6000 tons in the same time. The argument has been presented in all sincerity, that mechanical methods cannot be used to the same advantage in quarrying rock as in the case of general manufacturing. To some extent this is true, depending upon the class of quarrying; for instance, in some quarries producing rough rubble without regard to size or dimensions, the mechanical features are confined to drilling, electrical blasting and suitable hoisting apparatus and perhaps pumping or crushing, with the occasional use of steam shovels. There can be no question as to the economy of machine drilling over hand drilling, and the harder the material and the more difficult to drill by hand, the greater is the advantage of machine drilling.

Successful quarries are those which closely approach the ideal of eliminating hand labor and, as in other profitable operations, are the result of heavy investments in all the machinery which can be used up to that point where additional apparatus will not reduce the waste. The modern methods of clanneling, plug and feather work, power wedge hole cutters and the use of compressed air, very nearly reach this point as it calls for few machine operators, a few men to bar out the stone so loosened, and a gang of derrick men to place it on the cars for shipment in that attractive form best calculated to hold and expand the market at the highest trade price for the product. In most quarries, the operating period is limited by the comparative shortness of the working season, and therein lies another advantage of machinery. Again, the smaller the force, the more easily it is controlled and the better the opportunity for sifting the men down to a picked gang of machine runners, men who, at a slight addition over the prevailing rate of wages, will not only do very much more work, but will come nearer to the production of a perfect output without wasteage.

There exists in the stone industry the same tendency toward the concentration of capital and the formation of stock companies as in other branches of trade. This is due not altogether to the desire for combination with a view to controlling trade, but in part at least to a change which has taken place in the character of the industry. The installation of costly machinery and the fact that the quarries in many cases now contract not merely to furnish the stone, but to furnish it cut and ready for its definite position in the structure, even if they do not contract to set it in place as well, involve a larger capitalization and supply of available funds. See MINES AND MINING; MINING AND MILLING MACHINERY; BUILDING MATERIALS; ETC.

EDWARD S. FARROW,
Consulting Mining Engineer.

Quart. See WEIGHTS AND MEASURES.

Quarter. See WEIGHTS AND MEASURES.

Quarter-crack. See SANDCRACK.

Quarter Days, the days which begin the four quarters of the year, namely: 25 March, or Lady-day; 24 June, or Midsummer-day; 29 September, or Michaelmas-day; and 25 December, or Christmas-day. In England and Ireland it is usually contracted between landlord and tenant that rent should be paid, and that houses may be entered or left on these days. In Scotland there are two legal term days, Whitsunday (15 May) and Martinmas (11 November). There are also two conventional terms, Candlemas (2 February) and Lammas (1 August), on which rents are frequently paid. In the United States, in law, quarter days are the 1st of January, April, July, and October. In the relation between landlord and tenant in some of the States they are the 1st of May, August, November, and February, respectively.

Quarter Dollar, in American coinage, a silver piece of the value of 25 cents. Its issue was first authorized (weight, 104 grains) by Congress in 1792, and its coinage was begun in 1796. It was reduced to 93 grains in 1853. This coin is legal tender to the amount of $10. There were no issues of the quarter dollar during the years 1798 to 1803, inclusive, 1808 to 1815 inclusive, 1817, 1824, 1826 and 1830.

Quarter Sessions. See COURT.

Quarter-staff, an old English weapon formed of a stout pole of heavy wood, about six feet long, loaded with iron at both ends.

Quartering Acts, acts of the British Parliament which did away with certain of the penalties of high treason as prescribed by law in ancient times. The offender, if a man, was drawn on a hurdle to the place of execution, there hanged by the neck till he was dead, the head severed from the body, the body disemboweled and divided into four quarters, and the head disposed of at the pleasure of the king. If the offender was a woman she was drawn to the place of execution and there burned alive. By successive acts of the parliament (30 Geo. III. ch. 48, and 54 Geo. II. ch. 146) the punishment of a female traitor was changed to hanging; and, in the case of men, the crown might change the sentence to beheading, or might remit it wholly. Under the felony act of 1870 hanging is made the one penalty of treason: but as the act 54 Geo. III. ch. 146 was not repealed, the offender, if a man, may by crown warrant be beheaded.

Quartermaster, (1) in military affairs, an officer who superintends the issue of stores, food, and clothing, and arranges transportation for a regiment when necessary. (2) In nautical affairs, a petty officer who, besides having charge of the stowage of ballast and provisions, coiling of ropes, etc., attends to the steering of the ship. He is appointed by the captain.

Quartermaster-general, in the army of the United States, a staff-officer with rank of brigadier-general. He is chief officer in the quartermaster's department. In England he is a staff-officer, specially appointed for duties connected with quartering, encamping, embarking, and moving troops. In both armies in the field he is responsible for the surveys and reconnaissance necessary for the conduct of the army, and has the general direction of the railway, postal, signaling, and telegraph services.

Quartermaster-sergeant, in the United States army, an officer whose duty it is to assist the quartermaster. In England the senior sergeant in the quartermaster's department of a regiment. He ranks next the sergeant-major.

Quar'tern. See Weights and Measures.

Quarteroon'. See Quadroon.

Quartet', or **Quartette** (Italian *quartetto* from *quarto,* a fourth), a musical composition for four voices or instruments, in which all the parts are *obbligati,* that is to say, each is indispensable to the just performance of the piece; no one part can be omitted without injuring the proper effect of the composition. Vocal quartets are generally accompanied by instruments to sustain the voices, but the most artistic effect is produced by their perfect rendition unaccompanied. An interchange of melody, whereby the parts become in turn principal and subordinate, without any interweaving of them, does not constitute a quartet (see Polyphony). Quartets for stringed instruments are generally arranged for two violins, a viola or tenor violin, and a violoncello. Haydn was the originator of the modern instrumental quartet, and his contemporary emulators were Mozart, Beethoven, Gietry, Sammartini, Onslow, the two Rombergs, and Ries. Among later masters of the quartet form are Schubert and Brahms.

Quartier Latin, kăr-tē-ā lā-tăn. See Paris.

Quartley, kwârt'lĭ, **Arthur,** American artist: b. Paris 24 May 1839; d. New York 24 May 1886. Coming to the United States in 1851, he studied in Baltimore and New York and was elected National Academician in 1886. His most important works are marines, and among them may be mentioned 'New York from North River'; 'Afternoon in August — Coast of Maine' (1778); 'Low Country on the North Shore of Long Island' (1881); and 'Off the Shoals.'

Quarto, the name applied to the size of a book, in which a sheet makes four leaves, frequently abbreviated to 4to. Also a book formed by folding a sheet twice, making four leaves, eight pages. The term, by modern usage, refers to a book of nearly square form.

Quartodecimans, kwăr-tō-dĕs'ĭ-manz, the name given to those Christians in the early centuries who celebrated the Easter festival on the same day as the Jews celebrated the Passover, namely the 14th day of the month Nisan. Most of the churches, both of the East and West, celebrated the Christian Passover always on the *Sunday* next succeeding the day observed by the Jews, never on 14th Nisan, even if that day was Sunday. The Council of Nice (325 a.d.) enjoined on all the faithful this rule; thereafter the Quartodecimans were held to be heretics.

Quartz, the name given native oxide of silicon, SiO_2. It is a widely distributed mineral, occurring not only as veins and segregated masses, but as a common constituent of igneous rocks. Detrital grains form sands, sandstones, and quartzites. Owing to differences in color and texture and its use as a semi-precious stone, the names given varieties of quartz are many. All these varieties, however, are included in two classes, the plainly crystalline or vitreous, and the obscurely crystalline called crypto-crystalline. All varieties have about the same hardness, 7, that is, can scratch window glass, and nearly the same specific gravity, 2.6. Pure quartz is fusible only at high temperatures.

Quartz crystallizes in the rhombohedral system, generally as six-sided prisms usually terminated at each end by six-sided pyramids. Among the crystalline varieties of quartz are rock crystal, amethyst, smoky quartz, rose quartz, milky quartz, the mineral being colorless when pure, but ranging through various shades of yellow, red, brown, blue, and green to black when impure. Colorless quartz, or rock crystal, is often cut into gem shapes and sold as Lake George diamonds, Brazil pebbles, etc. Perfectly clear crystals of larger size are highly prized in Japan, when cut and polished as spheres. Recently developed uses of rock crystal are in the manufacture of fibres for suspending the minute magnets and mirrors used as galvanometers and in the manufacture of spectrum tubes and test tubes, the quartz being fused by the oxyhydrogen blowpipe. Quartz fibres are used for galvanometers because they show no torsion and the minors have no permanent set or deviation from the true position when at rest. Vessels made of fused quartz can be heated to a white heat and plunged into cold water without injury and on this account quartz tubes are used for studying the spectra gases at high temperatures.

Of the colored varieties of crystalline quartz amethyst is clear purple or bluish-violet, and is popular as a gem; rose quartz, which always occurs massive, is rose red or pink; yellow quartz, or citrine, is often called topaz by jewelers, but may be distinguished from true topaz by its inferior hardness; smoky quartz, called also cairngorm stone, varies in color from smoky yellow to brownish black; milky quartz, white, nearly opaque and often with a greasy lustre, is of common occurrence in veins; sagenitic quartz has inclusions of needle-like crystals of rutile, actinolite, asbestos (cat's-eye) or black tourmaline; sapphire quartz indigo blue in color, is a rare variety. Many quartz crystals contain small cavities partly filled with liquids, generally water, also inclusions of carbonic acid, either liquid or gaseous. The cryptocrystalline varieties of quartz include chalcedony, and its varieties, carnelian, chrysoprase, prase, plasma, agate, onyx, and sardonyx; also flint, hornstone, touchstone, and jasper. Chalcedony has a wax-like lustre, is translucent or transparent, and its color varies from white through pale brown to dark brown or black, though it is occasionally blue; carnelian, or sand, is a red or brownish-red chalcedony; chrysoprase an apple-green variety; prase, a dull darker green; plasma, a leek green or emerald green; bloodstone, a dark green chalcedony with small red spots, like drops of blood; agate, a chalcedony with delicate parallel bands of color, or irregularly clouded color effects, the colors being white, red, brown, or even blue, while moss agate contains moss-like forms caused by oxide of manganese; in onyx the differently colored bands are straight and parallel; sardonyx is onyx containing bands of carnelian (sand); flint differs from chalcedony in being more opaque, having a slightly vitreous lustre, being generally gray or brown in color; it breaks with a sharp cutting edge; it was used by the early races of men for arrow heads, knives, etc.; hornstone resembles flint, but has a splintery fracture, and is often white; touchstone, known also as basanite or Lydian stone, a black hornstone or jasper, used for testing the purity of precious metals by rubbing them on it; jasper differs from the preceding varieties in being entirely opaque; it is often red, yellow, or brown.

Common milky quartz is used for a variety of purposes. In metallurgical operations it is used as a flux in smelting iron and copper ores; when finely crushed it is used by porcelain manufacturers for making glazes, quartz sand and ground pure quartz are used in immense quantities for making glass. Another use is as an abrasive, either as sandpaper or as sand or a fine powder. In these forms it is used for dressing stone, wood, and leather; while the powder, mixed with soap, forms a widely advertised cleansing compound.

Quartz Porphyry, an igneous rock characterized by containing crystals of quartz and feldspar with sometimes biotite and more rarely hornblende scattered through a ground mass that is glassy or contains fine crystals of quartz and feldspar. The name was formerly given to free Tertiary rhyolites and is still applied to rhyolites that have crystallized as dikes or laccolites rather than as surface flows, but these distinctions have little value. In general quartz porphyries differ from rhyolites simply in being denser. Quartz trachyte is a name given rhyolite by European geologists. Quartz porphyries are of quite common occurrence in the Western States and are of peculiar importance at Leadville, Colo. See RHYOLITE.

Quartzite, a sedimentary rock of common occurrence in mountain ranges or when strata have been strongly folded. It is simply a metamorphosed sandstone, its hardness and rather crystalline character being due to the cement of crystalline quartz that surrounds the grains of the original sandstone. A sandstone containing clay becomes a quartzite containing mica, and thus quartzites grade into quartz-schists and mica-schists. In general, quartzites resist weathering and thus form ledges. They differ greatly in color. See also GLACIAL PERIOD.

Quasimo'do, in the Roman calendar, a term applied to the first Sunday after Easter, from the opening words of the introit for that day, "*quasi modo geniti infantes,*" as infants lately born. Also the name of a well known character in Victor Hugo's novel 'Notre Dame de Paris.'

Quass, kwäs, or **Kvass**, a Russian beverage, made by pouring warm water on rye or barley meal. It is sour and fermented.

Quas'sia, a genus of shrubs and trees of the order *Simarubaceæ*. The best known species (*Q. amara*) is indigenous to tropical America, grows about 12 feet tall, bears large pinnate leaves with winged petioles, and racemes of bright red blossoms. The wood is used for cabinet making and for furniture, since it is avoided by insects. It is excessively bitter, and was formerly in repute as a medicine and for augmenting the bitterness of ale, porter, beer, and similar beverages. It is known also as bitterwood, by which name the wood of *Picræna excelsa* is likewise designated and used as a substitute for true quassia with which it vies in bitterness.

Quater'nary, or **Post-Tertiary Period**, in geology, the fourth great division of the fossiliferous strata, which embraces the Pleistocene or Glacial and Post-Glacial (q.v.) and recent systems. See POST-PLIOCENE.

Quaternions. *Fundamental Principles.*—A quaternion, or "set of four," is a quadrinomial of the form

$$w+xi+yj+zk,$$

in which w, x, y, z are numbers, and 1, i, j, k are four independent units, any three of which may be interpreted geometrically as a set of mutually perpendicular straight lines of unit length in three-dimensional space. The binary products xi, yj, zk are three mutually perpendicular line-segments of lengths x, y, z respectively: they are called *vectors*, while pure numbers, positive or negative, are called *scalars*.

The calculus of quaternions is an algebra in which the fundamental operations of addition, subtraction, multiplication, and division, and the consequent operations of involution, evolution, etc., are employed, and whose elements (operators and operands) are quaternions. It is a multiple algebra, because a quaternionic symbol, as q, contains implicitly several independent quantities, and it is essentially geometric, because its operations, addition, multiplication, etc., may be interpreted as geometric transformations. For example, in illustration of the last statement, if q, r be two quaternions and be taken to represent two line-segments meeting at a point, their sum is the diagonal of the parallelogram of which q and r are two adjacent sides. This is known as geometric addition; its law is that of the parallelogram of forces. Multiplication by a quaternion is equivalent to an orthogonal transformation in four variables plus an expansion or a contraction. The geometrical construction of a quaternion product, however, needs the hypothesis of a four-dimensional space for its proper presentation.*

Vectors in particular are so defined as to obey the law of geometric addition. If several vectors represent the successive parts of a broken line in space, their sum is the line-segment joining the free ends of the broken line. In this process of addition the line-segments representing vectors may be transferred to any positions in space, provided they remain parallel to their original directions, but the direction-sense must in every case be preserved.

In obedience to this interpretation a quaternion may always be written as the sum of a scalar and a vector; thus,

$$q = Sq + Vq,$$

wherein S and V are to be read 'scalar of' and 'vector of' respectively; for, by the law of geometric addition $xi+yj+zk$ is itself a vector, while w, being a pure number, is by definition a scalar.

In the quaternion algebra the laws of association and distribution in the four fundamental operations, and the law of commutation in addition and subtraction, are assumed, or they may be derived from the geometrical definitions of the processes, but the commutative law in multiplication and division is rejected except for such quaternions as have vector parts that are numerical multiples of one another.

The laws of combination by multiplication are determined in the following manner: The mutually perpendicular vectors xi, yj, zk are numerical multiples of the three independent units, i, j, k, and the combinatory laws for these units are derived from the assumptions

$$i^2=j^2=k^2=-1, \quad ijk=-1,$$

from which are obtained, through multiplication by i, j, k in succession, the remaining binary products

$$jk=-kj=i, \quad ki=-ik=j, \quad ij=-ji=k,$$

From these laws it follows that the product of two quaternions is itself a quaternion. Thus q and r being given quaternions,

$$\begin{aligned} q &= w+xi+yj+zk, \\ r &= w'+x'i+y'j+z'k, \end{aligned}$$

their product has the form

$$qr = W+Xi+Yj+Zk,$$

wherein

$$\begin{aligned} W &= ww'-xx'-yy'-zz', \\ X &= wx'+w'x+yz'-y'z, \\ Y &= wy'+w'y+zx'-z'x, \\ Z &= wz'+w'z+xy'-x'y. \end{aligned}$$

If the order of the factors in this product be changed from qr to rq, the scalar part $ww'-xx'-yy'-zz'$ is unaltered, but the terms $yz'-y'z$, $zx'-z'x$, $xy'-x'y$ change their algebraic signs and therefore the vectors of qr and of rq are different. This result shows that in general quaternion multiplication does not obey the commutative law. In order that the above terms may not change sign (by a reversal of the order of the factors q, r) they must be separately zero, that is,

$$\frac{y}{y'}=\frac{z}{z'}, \quad \frac{z}{z'}=\frac{x}{x'}, \quad \frac{x}{x'}=\frac{y}{y'},$$

in other words, x', y', z' must be the same numerical multiples of x, y, z respectively. This makes $x'i+y'j+z'k$ a numerical multiple of $xi+yj+zk$, and it is the condition under which it is permissible to write $qr=rq$.

Division is interpreted by introducing the reciprocal, defined by the equation $qr=1$, in which q and r are said to be reciprocal to one another, and, as in ordinary algebra, we write $r=q^{-1}$ and $q=r^{-1}$. This product obviously obeys the commutative law and also it has no vector part, so that

$$x'=nx, \quad y'=ny, \quad z'=nz, \qquad [n = \text{a number}]$$

and

$$wnx=-w'x, \quad w'=-nw.$$

Hence the reciprocal of q must have the form

$$q^{-1}=\frac{1}{m}(w-xi-yj-zk),$$

where m is a number. By forming the product qq^{-1}, observing the laws $i^2=j^2=k^2=-1$, $ij=-ji=k$, etc., it is easily shown that

$$m=w^2+x^2+y^2+z^2.$$

This number is called the *norm* of q.

It is now evident that the quotient rq^{-1} is obtained by writing out the product

$$(w'+x'i+y'j+z'k)\cdot\frac{1}{m}(w-xi-yj-zk),$$

and that this quotient is a quaternion.

Hence, barring critical cases, such as division by zero, indeterminate forms, etc., the application of the four fundamental processes of algebra to quaternion symbols leads always to determinate quaternion results. The quaternionic algebra is therefore a closed system and satisfies the definitions of a group. (See THEORY OF GROUPS.)

The positive square root of the norm of q $(=+\sqrt{w^2+x^2+y^2+z^2})$ is called its *tensor* and the quotient of q by tensor of q is called its *versor*, so that a quaternion is always the product of its tensor and versor. The symbolic form of this statement is

$$q = Tq \cdot Uq,$$

where T and U stand for tensor and versor respectively.

In the strictly symbolic notation the reciprocal of q has the form

$$q^{-1}=\frac{Sq-Vq}{T^2q},$$

and since $qq^{-1}=1$ it follows that

$$S^2q-V^2q=T^2q.$$

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* See 'Bulletin of the American Mathematical Society' (vol. 11, p. [illegible]).

The quaternions $Sq+Vq$ and $Sq-Vq$ are said said to be *conjugates* of one another.

A vector has no scalar part, but it has a tensor factor and a versor (vector of unit length); and a scalar has no versor part, but it has a tensor, its positive numerical value, and a versor whose value is always ±1. The symbolic statements are

$$Vq=TVq\cdot UVq,$$
$$Sq=\pm TSq.$$

Therefore, also,

$$V^2q=-T^2Vq, \quad S^2q=T^2Sq.$$

The equation $S^2q-V^2q=T^2q$ may now be written

$$S^2q+T^2Vq=T^2q,$$

and hence, θ being an appropriate angle, it may be assumed that

$$Sq=Tq\cdot\cos\theta, \quad Vq=Tq\cdot UVq\cdot\sin\theta.$$

By the introduction of these expressions for scalar and vector the quaternion is presented in a new binomial form

$$q=Tq(\cos\theta+UVq\cdot\sin\theta),$$

one of great importance and utility.

The formula last written is a particular case of a more general geometric law. A recent interpretation makes quaternion symbols represent straight-line segments (their directions included) in four-dimensional space.* Interpreted in this way quaternions are called *directors*. It is shown that if two quaternion directors be perpendicular to one another their quotient is a vector. Let θ be the angle between p and q, let s be the director perpendicular dropped from the terminal extremity of q to p, and r the director from the origin (intersection of p, q) to the foot of this perpendicular. Then by geometric addition

$$q=r+s$$

and

$$q/p=r/p+s/p;$$

and s/p, being the quotient of a pair of mutually perpendicular directors, is a vector. Hence, if ρ be the ratio Us/Up, it is a unit vector and

$$q/p=\frac{Tq}{Tp}(\cos\theta+\rho\sin\theta).$$

When $p=1$ this equation reduces to the one previously written for the value of q. In this particular case θ becomes the angle formed by the quaternion director q with the axis of real quantities, or scalar axis. When p and q are both vectors the formula expresses the fact, on which Hamilton places early emphasis, that the ratio of two vectors is in general a quaternion, but that if the vectors meet at a right angle the ratio is another vector, if they be parallel it is a scalar. But the formula also shows that these statements are true of quaternions in general.

The two parts of the equation last written present the quaternion under its three most fundamental aspects:

1. It is the ratio of two directed, nonposited,† straight-line segments.

2. It is the sum of a number and a directed, non-posited vector.

3. It is the product of a tensor (tensor of q/p) and of a versor, the latter being expressed in terms of its angle θ, and its vector axis ρ.

The geometrical and kinematical interpretations of geometric addition and subtraction involve no special difficulties. They are fully explained in a variety of treatises in which this subject has its natural place, particularly in those parts of mathematical physics where the composition of velocities and of forces is explained. The first full exposition of the subject was given in the celebrated 'Barycentrische Calcül' of Möbius, published in 1827, and was therefore well known about sixteen years before the invention of the calculus of quaternions by Hamilton.

The non-commutative character of multiplication greatly enlarges its powers of expression and discrimination, but it also introduces troublesome transformation processes and calls for extended analysis. Fully expressed, the quaternion product has the double form $q(\ )q_1$ and involves eight scalar quantities. A first step in its analysis resolves it, in either of two important ways, into simpler factors:

1. Since by the law of association

$$q(\ )q_1=1[q(\ )1]q_1=q[1(\ )q_1]1,$$

it consists of the two special commutative operators $q(\ )1$, $1(\ )q_1$, applied in succession, or simultaneously, at pleasure.

2. It is always possible to determine four versor quaternions r, s, r_1, s_1, that satisfy the following conditions:

$$Uq=rs=sr, \quad Uq_1=r_1^{-1}s_1=s_1r_1^{-1},$$

and

$$Sr=Sr_1, \quad Ss=Ss_1.\text{*}$$

The given product then assumes the form

$$mq(\ )q_1=mr[s(\ )s_1]r_1^{-1}=ms[r(\ )r_1^{-1}]s_1,$$

where m is a number. It consists of a tensor factor and two rotational transformations $r(\ )r_1^{-1}$, $s(\ )s_1$ which are commutative and may be applied simultaneously, or in succession.

The interpretation of the special products $q(\ )1$, $1(\ )q_1$, $r(\ )r_1^{-1}$, $s(\ )s_1^{-1}$, as motions, 'turns,' and 'rotations,' generally in a space of four dimensions, has been successfully achieved.† An adequate account of them, however, would expand this notice beyond permissible limits. No accurate description of the motion represented by the general product $q(\ )q_1$ has yet been given.

A simpler case than any of the preceding is the product $q(\ )q^{-1}$. Its complete interpretation as a rotation in three-dimensional space was an early achievement by Hamilton himself. The motion consists of a rotation through twice the angle of q (q being given in the form $m[\cos\theta+\rho\sin\theta]$) about the vector of q as an axis; that is, any vector, placed at the origin, moves through the angle 2θ, on the surface of a cone having its vertex at the origin.[*]

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* 'Transactions of the American Mathematical Society (vol. 2, pp. 183–214, and vol. 3, pp. 46–59).

† Not placed in a definite position.

* 'Proceedings of the American Association for the Advancement of Science' (vol. 33, 1884, pp. 55–56).

† See Hathaway in 'Transactions of the American Mathematical Society' (vol. 3, 1902, pp. 46–59), and Stringham in 'Proceedings of the American Association for the Advancement of Science' (vol. 33 1884, p. 56).

Quaternion multiplications may be expressed in terms of matrices. This fact was first established by Peirce,[†] afterwards verified by Spottiswoode,[‡] but more explicitly by Cayley.[§] It has also been shown that every orthogonal transformation in four variables is expressible as a quaternion product.[‖] Such facts as these bring out clearly the multiple character of the quaternion algebra.

The further development of the theory of quaternions, which follows the exposition of fundamental principles outlined in the preceding paragraphs, includes the deduction of the formulæ of scalar and vector products and quotients, the interpretation and transformation of quaternion expressions in general, the differentiation of quaternions, the solution of equations, especially of equations of the first degree, and the analytical theory of quaternions.

But although the works of Hamilton and Tait contain a large mass of material concerning particular quaternion transformations, the general Analytical Theory of Quaternions has yet to be written. A brief outline sketch of a method is given by Cayley in the sixth chapter of Tait's Treatise.

Applications.—It is impossible, in the space permitted to this notice, to do more than name some of the subjects in which the method of quaternions finds its applications. The most important of these to which writers have thus far given attention are the following:

The theory of matrices; orthogonal transformation; geometry of the straight line, of the plane, of the sphere, of the cyclic cone, of surfaces of the second order, of curves and surfaces in general, and of planes in four-dimensional space; kinematics of a point, of a rigid system, and of deformable systems; axes and moments of inertia; statics of a rigid system; kinetics of a rigid system; precession and nutation; the problems of the pendulum; geometrical and physical optics; electrodynamics; the solenoid; applications of the operator, $\nabla = i\frac{d}{dx} + j\frac{d}{dy} + k\frac{d}{dz}$, and of Laplace's operator ∇^2, to physical analogics, to line, surface, and volume integrals, to the stress function; application of the ∇ integrals to magnetic problems; the hydrokinetic equations; applications of ∇ in connection with Taylor's theorem and the calculus of variations.

By far the greater portion of extant knowledge of quaternions, both of the theory and of its applications, is due directly to Hamilton and is published in the 'Elements,' but the applications to physical problems were mainly contributed by Tait and are embodied in the twelfth chapter of his 'Treatise.'

History.—The development of the quaternion calculus as an analysis of space relations was the work of Sir William Rowan Hamilton, Andrews Professor of Astronomy in the University of Dublin and Royal Astronomer of Ireland. The effort to create a new calculus of this type was a natural sequence of the many attempts that had been made to interpret geometrically the so-called imaginary and complex algebraic expressions of the forms $a\sqrt{-1}$ and $a+b\sqrt{-1}$. These attempts are recorded in the earlier works whose titles are given in the following bibliography.

Hamilton laid the foundations of the new subject during the years 1833–1843. In November of the latter year his first paper on 'Researches respecting Quaternions' was presented to the Royal Irish Academy. His first full exposition of quaternion theory was published in 1853 in his 'Lectures on Quaternions,' a book of over seven hundred pages.

Meanwhile, in 1844, Grassmann published his now celebrated work, 'Die Ausdehnungslehre,' which occupies common ground with quaternion theory, but plans a much wider range of investigation than was contemplated by Hamilton in his system. The two systems have a common body of fundamental principles, but they have different points of view, different notations, and in part different purposes. Both form the foundations upon which all subsequent work of the kind must stand.

Hamilton's 'Elements of Quaternions,' which still remains the storehouse of knowledge for its subject, was a posthumous work, published in 1866. A new edition has recently appeared in two volumes.

After the work of Hamilton and Grassmann had been finished the next most important forward step in the creation of new algebras was taken by Benjamin Peirce in his essay on 'Linear Associative Algebra,' presented to the National Academy of Sciences at Washington in 1870, subsequently published in the 'American Journal of Mathematics' (1881). In this work the author enumerates the types of linear associative algebras, and classifies them by a set of criteria which takes account of the number and the assumed laws of combination of their irreducible elements (extraordinaries, or vids). These laws are exhibited in the form of a series of multiplication tables.

Some of the more recent attempts to apply the quaternion analysis and the Ausdehnungslehre to physical problems have appeared under the title of 'Vector Analysis,' sometimes with modified, sometimes with wholly changed notations. Of these the contributions of Willard Gibbs and of Heaviside should be mentioned as of special importance.

Bibliography.—The following bibliography, though not exhaustive, enumerates, in strict chronological order, the most important titles of books and monographs that have been published on the subject of quaternions and its closely allied branches. The later dates, where two or more are attached to a single title, are the dates of new editions, or of continuations of a series of papers: Wallis, 'Treatise of Algebra' (1685); Abbé Bueé, 'Mémoire sur les Quantités imaginaire' (read in June, 1805, 'Phil Trans.,' 1806); Argand, 'Essai sur une manière de representer les quantités imaginaires dans les constructions géométriques’ (1806); Français, ‘Papers on the Interpretation of Imaginaries in Gergonne’s Annales’ (1813); Gauss, ‘Verwendung complexer Grössen für die Geometrie’ (1819–1852) (Werke, Band VIII), and ‘Theoria Residuorum Biquadraticorum’ (1825, 1831) (Werke, Band II); Möbius, ‘Der Barycentrische Calcul’ (1827); Mourey, ‘La vrai Théorie des Quantités Négatives et des Quantités prétendues imaginaires’ (1828); Warren, ‘Treatise on the Geometrical Representation of the Square Roots of Negative Quantities’ (1828); Bellavitis, ‘Calcolo delle Equipollenze’ (1835); Hamilton, ‘Papers in the Royal Irish Academy Transactions’ (Vols. XVII, XXI), ‘Philosophical Magazine,’ etc., on ‘Conjugate Functions,’ ‘Algebraic Couples,’ and ‘Quaternions’ (1835–1843); H. Grassmann, ‘Die Ausdehnungslehre’ (1844 1862, 1878); De Morgan, ‘Trigonometry and Double Algebra’ (1849); O’Brien, ‘Symbolic Forms Derived from the Conception of the Translation of a Directed Magnitude’ (in ‘Phil. Trans.,’ 1851); Hamilton, ‘Lectures on Quaternions’ (1853); Allegret, ‘Essai sur le Calcul des Quaternions’ (1862); Hamilton, ‘Elements of Quaternions’ (1866); Tait, ‘Treatise on Quaternions’ (1867, 1873, 1890); Hankel, ‘Vorlesungen über die complexen Zahlen und ihre Functionen’ (1867); Benjamin Peirce, ‘Linear Associative Algebra’ (1870, 1881); Schlegel, ‘System der Raumlehre’ (1872); Clifford, ‘Preliminary Sketch of Biquaternions,’ in ‘Proceedings of London Mathematical Society’ (1873); Kelland and Tait, ‘Introduction to Quaternions’ (1873, 1882); Höuel, ‘Théorie des Quantités complexes’ (1874); Laisant, ‘Applications mécaniques du Calcul des Quaternions’ (1877), and ‘Introduction à la Méthode des Quaternions’ (1881); Hardy, ‘Elements of Quaternions’ (1881); Gibbs, ‘Elements of Vector Analysis’ (1881–1884); Graefe, ‘Vorlesungen über die Théorie der Quaternionen’ (1883); Buchheim, ‘A Memoir on Biquaternions,’ in ‘American Journal of Mathematics’ (1885); Heaviside, ‘Vector Analysis,’ in ‘Reprint of Electrical Papers’ (1885–1892); Peano, ‘Calcolo geometrico secondo l’Ausdehnungslehre di H. Grassmann’ (1888); Hyde, ‘The Directional Calculus’ (1890); Macfarlane, ‘Principles of the Algebra of Physics’ (1891), and ‘Papers on Space Anaylsis’ (1891–1893); Kraft, ‘Abriss des geometrischen Kalküls’ (1893); Föppl, ‘Vorlesungen über die Maxwell’sche Theorie der Electricität’ (1894); Hime, ‘Outlines of Quaternions’ (1894); Hagen, ‘Synopsis der hoeheren Mathematik’ (vol. 2, 1895); Hathaway, ‘A Primer of Quaternions’ (1896); Macfarlane, ‘Vector Analysis and Quaternions,’ in ‘Higher Mathematics’ (1896); McAulay, ‘Octonians’ (1898); Stringham, ‘On the Geometry of Planes in a Parabolic Space of Four Dimensions,’ in ‘Transactions of American Mathematical Society’ (1901); Gibbs and Wilson, ‘Vector Analysis’ (1901); Hathaway, ‘Quaternion Space,’ in ‘Transactions of American Mathematical Society’ (1902); Henrici and Turner, ‘Vectors and Rotors’ (1903).

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[*] Tait's 'Treatise on Quaternions' (3d edition, pp. 75 and 289).

[†] In a foot-note in Linear 'Associative Algebra,' 'American Journal of Mathematics' (vol. 4, 1881, p. 132).

[‡] In 'Proceedings of the London Mathematical Society' vol. 4, 1872, pp. 156–159).

[§] In Tait's 'Treatise on Quaternions' (3d edition, p. 148), and Cayley's 'Mathematical Papers' (vol. 12, pp. 311–313).

[‖] In 'Transactions of the American Mathematical Society' (vol. 2, 1901, pp. 186, 187). See also the references to Cayley and Klein on page 184 of this volume, and 'Compte Rendu du deuxième Congrès Internationale des Mathématiciens' (Paris, 1900, p. 336).

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Quat'rain, a poetical composition of four verses rhyming alternately, a usual form for epigrams, epitaphs, proverbs, etc.; stanzas of four verses in a longer piece of poetry are also called quatrains, if each stanza expresses by itself a complete idea.

Quatre-Bras, kätr-brä (‘four branches’), Belgium, in the province of Brabant; at the intersection of the main roads from Brussels and Charleroi and from Namur to Nivelles; about 20 miles south-southeast of Brussels. It is famous for the battle fought here, 16 June 1815, between the English under Wellington and the French under Ney. It was Napoleon's plan at the opening of the campaign of 1815 to fight the armies of the allies singly, as he felt himself unable to cope with their combined forces. At the head of an army of 129,000 men, supported by 350 guns, he made a rapid march into Belgium, crossing the Sambre almost before the allies were aware of his movements. His army was divided into three corps: the right wing, 48,000 strong, being under Grouchy; the centre, of 28,000 men, under the emperor himself; and the left wing, of 48,000, under Ney. The Prussians and English under Blücher and Wellington lay between the French and Brussels. With the right wing and centre of his army Napoleon furiously attacked the Prussians, who, after a severe struggle, retired upon Wavre 16 June. On the same day Ney attacked Wellington at Quatre-Bras. The English, 32,000 strong, repulsed Ney, and maintained their position, though at a loss of over 5,000 men, including the Duke of Brunswick. The English general, hearing of the retrograde movement of the Prussians, fell back on the 17th on Waterloo, where the decisive battle was fought on the following day.

Quatre-Vingt-Treize, kätr-văṅ-trāz (‘Ninety-Three’), a work of historical fiction by Victor Hugo, published in 1874. The time is, as the title indicates, 1793. The scene is Vendée, during the civil war. In its style it displays much unevenness, but in its characters, vivid scenes, and tragic catastrophe ranks among the author's best.

Quatrefages de Bréau, Jean Louis Armand de, zhŏṅ loo-e är-mäṅ dė kätr-fäzh dė brā-ō, French naturalist: b. Berthezène, Gard, France, 10 Feb. 1810; d. Paris, France, 12 Jan. 1892. He was graduated from the University of Strasburg and in 1832 settled in Toulouse, where he practised medicine and shortly afterward founded the ‘Journal de Médecine et de Chirurgie de Toulouse.’ In 1838–40 he occupied the chair of zoology at the University of Toulouse and in the latter year removed to Paris, where he made a special study of invertebrates. In 1850 he was appointed professor of natural history at the Lycée Napoléon, Paris, and in 1855 professor of anthropology at the Musée d'Histoire Naturelle, which post he occupied until his death. He was elected to the Academy of Sciences in 1852 and was widely known by his anthropological investigations. He was the first expounder of the doctrine of phlebenterism, and was strongly opposed to Darwin's theories. He was the author of many important works on zoology and anthropology, among which are: ‘Considérations sur les caractères zoologiques des rongeurs’ (1840); ‘De l'Organisation des Animaux sans vertèbres des côtes de la Manches’ (1844); ‘Recherches sur le Système nerveux, l'Embryogénie, les Organs des Sens, et la Circulation des Annélides’ (1844–50); ‘Physiologie Comparée, Metamorphose de l'Homme et des Animaux' (1862); 'Souvenirs d'un Naturaliste' (1854); 'Histoire Naturelle des Annelés Marins et d'Eau Douce' (1865); 'Les Polynésiens et leurs Migrations' (1866); 'La Rochelle et ses Environs' (1866); 'Rapport sur les Progrès de l'Anthropologie' (1867); 'Ch. Darwin et ses Precurseurs français' (1870), an attack on Darwinianism; 'La Race Prussienne' (1871); 'L'Espèce Humaine' (1877); 'Nouvelles Etudes sur la Distribution Géographique des Negritos' (1882); 'Hommes Fossiles et Hommes Sauvages' (1884); 'Introduction à l'Etude des Races Humaines' (1887–9); 'Théories Transformistes' (1892); a series of papers entitled 'Etudes sur les Types Inferieurs de l'Embranchement des Annelés'; and he also contributed a large number of articles to the 'Revue des Deux Mondes' on the results of his scientific researches along the Atlantic and Mediterranean coasts and throughout Italy and Sicily.

Quatrefoil, kăt'ĕr-foil, in architecture, an opening or a panel divided by cusps or foliations into four leaves, or more correctly the leaf-shaped figure formed by the cusps. It is an ornament which has been supposed to represent the four leaves of a cruciform flower, and is common in the tracery of Gothic windows. Bands of small quatrefoils are much used as ornaments in the perpendicular Gothic style, and sometimes in the decorated.

Quatremère, kätr-măr, **Etienne Marc,** French Orientalist: b. Paris, France, 12 July 1782; d. there 18 Sept. 1857. He was educated at the Collège de France, was employed at the Bibliothèque Impériale in 1807, and in 1809 accepted the chair of Greek in the University of Rouen. He was elected to the French Institute in 1815, became professor of Hebrew at the Collège de France in 1819, and in 1838 was made professor of Persian in the School for Living Oriental Languages. He made numerous valuable translations and was author of important geographical and historical works in addition to his work as an Orientalist. He published: 'Recherches Critiques et Historiques sur la Langue et la Littérature de l'Egypte' (1808); 'Mémoires géographiques et historiques sur l'Egypte' (1811); 'Mémoir le sur Nabateens' (1835); 'Histoire des Mongols de la Perse' (1836); 'Histoire des Sultans Mamelouks' (1837–45); etc.

Quatremère de Quincy, dĕ kăṅ-sē, **Antoine Chrysostome,** French archæologist and politician: b. Paris, 28 Oct. 1755; d. there 8 Dec. 1849. He was prominent politically under the republic, consulate, empire, and restoration, in 1791 having been deputy to the legislative assembly for Paris. After the dissolution of the assembly, he was 13 months in prison, and after the proscriptions of 1793 he became one of the leaders of the insurrection of 5 Oct. 1795, for which he was condemned to death. He was later acquitted and in 1797 represented the Seine in the council of five hundred, but for his opposition to the revolutionists was banished, 5 Sept. 1797. The consuls recalled him in 1799, and in 1800 he was appointed secretary to the council of the department of the Seine; later was appointed to the class of history and ancient literature in the national institute; was made permanent secretary of the Academy of Beaux-Arts in 1816, and was editor in that department of the 'Journal des Savants'; elected professor of archæology at the Royal Library in 1818 and serving as deputy in 1820–1. He wrote: 'Dictionnaire de l'Architecture' (1786–1825); 'Histoire de la Vie et des Ouvrages de Rafaël' (1824); 'Canova et ses Ouvrages' (1834); 'Le Jupiter Olympien, ou l'art de la sculpture antique' (1814); a treatise on ancient sculpture in ivory and gold; 'Essais sur l'Imitation dans les Beaux-Arts' (1823); 'Monuments et Ouvrages d'art antique restitués' (2 vols., 1826–8); 'Histoire de la vie et des Ouvrages des plus célèbres Architectes' (1836); etc.

Quatrocento, kwăt-rō-chĕn'tō, in **art,** a term applied to the characteristic style of the artists of the 14th century; it was hard, rigid, and peculiar in color as well as in form and pose. It was the intermediate stage of that progressive period of art which, commencing with Fra Angelico, reached excellence with Leonardo da Vinci.

Quay, kwā, **Matthew Stanley,** American politician: b. Dillsburg, York County, Pa., 30 Sept. 1833; d. Beaver, Pa., 28 May 1904. He was graduated from Jefferson College in 1850, studied law, was admitted to the bar in 1854, and elected prothonotary of Beaver County in 1856 and 1859. During the Civil War he was in active service as colonel of the 134th Pennsylvania regiment, being present at the battle of Fredericksburg; he was also assistant commissary general of Pennsylvania, State military agent at Washington, and military secretary to the governor. In 1865–7 he was a member of the Pennsylvania legislature; in 1872–8, and again in 1879–82, he was State secretary; recorder for the city of Philadelphia in 1878–9; and State treasurer in 1885. As early as 1869 he was secretary of the executive committee of the Republican State committee, and after that became the undisputed leader of his party in Pennsylvania. In national politics he was a member of the Republican national committee after 1885, and in 1888 was its chairman, conducting a successful Presidential campaign. In 1887 he was elected United States Senator, serving continuously till 1899; in that year a deadlock in the legislature prevented his re-election. This was in part owing to the fact that in 1898, on the failure of the People's Bank where State funds were deposited, he had been accused of being party to a conspiracy for the misappropriation of public funds; the trial occurred in April 1899, and resulted in his acquittal. He was then appointed Senator *ad interim* by the governor, and elected to the Senate in 1901 for the term expiring in 1905. In the Senate he was one of the strongest opponents of the Panama Canal. His power as a political organizer lay chiefly in his adroit methods of reconciling opposing factions and hostile interests. A striking example of this was his method of meeting the reform movement of 1902 by supporting as candidates for governor of the State and mayor of Philadelphia, men who were endorsed by the reformers and not prominent in the regular Republican organization, thus gaining the support of what might have been a dangerous opposition..

Quay, a landing-place along a line of coast or a river bank, or round a harbor. They are usually constructed of stone, but sometimes of wood and iron. See WHARF.

Quayle, kwāl, **William Alfred,** American Methodist clergyman and author: b. Missouri 1860. He was graduated from Baker University, Baldwin, Kan., in 1885, was ordained to the Methodist ministry the next year and has since held prominent pastorates in Kansas City and Indianapolis. He was professor of Greek at Baker University 1885–90, and president of that institution 1890–2. He has lectured widely and has published: 'The Poet's Poet and Other Essays' (1897); 'A Hero and Some Other Folk' (1900); 'The Blessed Life' (1901); 'The Gentleman in Literature' (1902); etc.

Quebec, kwē-bĕk (Fr. ké-bĕk), is one of the provinces of Canada, the second in rank, in British North America. Its capital is the city of Quebec.

Boundaries and Extent.—It is bounded on the north by Labrador and Hudson Bay, on the east by Labrador and the Gulf of Saint Lawrence, on the south by the Bay of Chaleurs, New Brunswick, and the States of Maine, New Hampshire, Vermont, and New York, and on the southwest by the River Ottawa, Lake Temiskaming, and the province of Ontario. Its length is nearly 1,000 miles on a due east and west course, its breadth is 300 miles, and its area 351,873 square miles. The surface of the country is varied and very picturesque, embracing several ranges of mountains and lofty hills, diversified by numerous rivers, lakes and forests.

Mountains.—The Notre-Dame, or Green, Mountains, a continuation of the Appalachian Range, extend along nearly the whole of the south side of the Saint Lawrence. That chain runs more or less far from the river, and, after crossing the frontier and the State of Vermont, joins the Alleghanies. The Laurentian Mountains skirt the northern bank of the same river and the Ottawa, somewhere near, and somewhere at a distance of 10, 15, or 30 miles from the banks, but 130 miles west of Montreal cross the Ottawa and curve in the direction of Kingston, whence they run westward to the shores of Lakes Superior and Huron.

Rivers, Lakes, and Islands.—Quebec abounds in large rivers, bays, and lakes. The Saint Lawrence, navigable for ships of over 5,000 tons as far as Montreal, flows through almost the entire length of the province, receiving, a short distance above Montreal, the waters of the Ottawa, a river 600 miles in length. That last river is more abundant in water than the Nile and the Rhine, and has large tributaries, the rivers Gatineau and Lièvre (Hare), which are over 200 miles long, and three others extending over 100 miles to the north. The Saint-Maurice, which rises in Lake Oskelaneo and empties into the Saint Lawrence at Three Rivers, is over 400 miles in length and is remarkable by its enormous flow of water and its falls. The principal, named Shawenegan, Grand 'Mère, La Tuque, Les Piles, are wonderful water-powers. Large pulp mills and paper factories have been erected at Grand 'Mère and at Shawenegan, a few years ago, and are now the centre of towns numbering 5,000 or 6,000 inhabitants. The rivers Batiscan, Sainte Anne, Jacques Cartier, and Montmorency, the last named famous for its falls, also enter the Saint Lawrence from the north. The Saguenay, rising in Lake Saint John and flowing into the Saint Lawrence at Tadousac, is one of the most remarkable bodies of water in the world, varying in depth from 100 to 1,000 feet. It is the great «exutoire» of the Lake Saint John, in which flow six long rivers; the principal one (the Peribonca) is 400 miles long and navigable for 30 miles. The Richelieu, draining Lake Champlain, discharges into the Saint Lawrence from the south, and so do the Saint Francis, Chaudiere, Chateauguay, Yamaska, Etchemin, Bécancour, and from the north, Assumption, Matawan, and du Loup. The largest lakes in the province are: Lake Saint John, with an area of 360 square miles, the Mistassini, the Temiskaming, and the Temiscouata. At three places the Saint Lawrence enlarges and forms lakes, named Saint Francis, the Saint Louis, and the Saint Pierre. The principal islands in the river Saint Lawrence are the islands of Montreal, of Orleans, near Quebec, Anticosti, and the Magdalen Islands, situated in the Gulf of Saint Lawrence, 50 miles north of Prince Edward Island.

Forests.—The province of Quebec is wealthy in forest lands and the numberless rivers and their branches make the handling of lumber extremely easy. The territory on the north side of the Saint Lawrence River is covered with forests which are to all practical purposes valueless owing to the abundance of small growth. Along the River Manicouagan and the Gulf and River Saint Lawrence, the timber is not only of good quality but grows in great quantity, including even scattering pine of value. Extending westward from the Manicouagan to the eastern watershed of the Gatineau, pine of the best quality is found, and lumbering has for a number of years been successfully carried on. In the district from which the Saguenay and its branches draw their waters is a vast quantity of pine, spruce, larch, and other woods. In the district drained by the Saint Maurice and its tributaries pine and spruce are most abundant.

In the Lower Ottawa region, including the vacant and waste lands of the Crown on the northern tributaries of the Lower Ottawa, and embracing the valleys of the rivers Assumption, Dunord, Petite Nation, the Blanche, and du Lièvre, in all 11,256 square miles, are to be found poplar, white and red pine, spruce, tamarack, and birch. In the Upper Ottawa territory is a great pine-growing district, but, while it is more valuable than the forests of the southern part of the province, it has not been worked to the same extent as that part, where the marvelous growth of brown birch, cedar, walnut, maple, and pine has been a valuable source of income. Scattered throughout the province are to be found elm, beech, ash, and cherry trees. The area of the lands on which lumber of merchantable value is to be found (not including that covered by small growth) is 116,521 square miles, of which 31,468 are covered with red and white pine and 85,053 with other woods.

Mines.—The Laurentian formation, which extends through the central portion of the province, holds thick beds of limestone and iron ore, titanic and magnetic, phosphate, plombagine, mica, and large deposits of graphite. Farther west the Laurentian formation is succeeded by the Potsdam sandstone. On this rests a dolomitic limestone, and the limestone of the Lower

Silurian Age, known as the Chazy and Trenton groups, are affording the best building stone of the province. There are many other minerals in the province of Quebec; but a few of them only are worked up (exploitees), namely, asbestos, ochre, chrome, copper (near Sherbrooke), lead, silver, and gold in Beauce district. In 1901 there was a remarkable progress and increase manifest in the mining of asbestos throughout the eastern townships in Quebec, and copper also assumed a more important place in the mining industry. The report of the Bureau of Mines for 1900–1 shows that 193 prospecting permits and 12 mining licenses were issued, the greater portion of these going to operators of asbestos mines, who in that year employed 1,500 to 2,000 men, and whose product was valued at $1,284,424. Pig iron to the extent of 14,449 tons was extracted by the blast furnaces at Radnor and Drummondville. The total value of the minerals extracted in the province was placed at $1,727,731, including, with asbestos as its largest item, iron ore valued at $30,978; copper ore at $126,500; mica at $39,600; ochre (calcined) at $14,595; cement at $28,000; and granite at $146,000. The mining industry employed 2,792 workmen, whose wages amounted to $865,110.

Climate.— The cold in Quebec in winter is generally steady; the thermometer often registers 20 degrees below zero, and the snow, falling to a great depth, lies on the ground from November until April. The extreme heat of summer, which is generally warm and pleasant, is indicated at 90°. But it is only exceptional that it runs up to that figure. Autumn, which lasts six or eight weeks, is the finest season of the year.

Agriculture.—Vegetation develops rapidly; there is a rich and loamy soil in much of the country. In the large valleys of the Saint Lawrence, of the Ottawa River, of the Matapedia, of the Richelieu, in the whole region of Lake Saint John, and in the eastern townships of the province, farming is the chief industry. The principal crops are wheat, barley, oats, rye, peas, buckwheat, potatoes, clover, hay, and corn. The lands lying in the vicinity of the State of Vermont are given to stock raising to a greater extent than to farming, and dairying has become an important branch of the trade of that district. In 1911 there were 1,672 cheese factories, 643 butter factories, and 691 factories of cheese and butter — the products of which having a total value of $25,000,000. In the stock-raising districts horse and cattle breeding has assumed the most important position, while sheep and swine are also raised to a great extent. Quebec has 3,084,300 live stock, viz., 371,400 horses, 872,800 milch cows, 609,200 other cattle, 533,400 sheep, 697,500 swine. The annual value of field crops is $85,000,000 to $100,000,000; of dairy products, $25,000,000. Oats, in 1910, yielded 48,927,000 bushels, valued at $21,187,000; potatoes, 21,271,000 bushels, valued at $9,359,000.

The field crops in 1910 totalled $97,000,000 in value and were as follows:

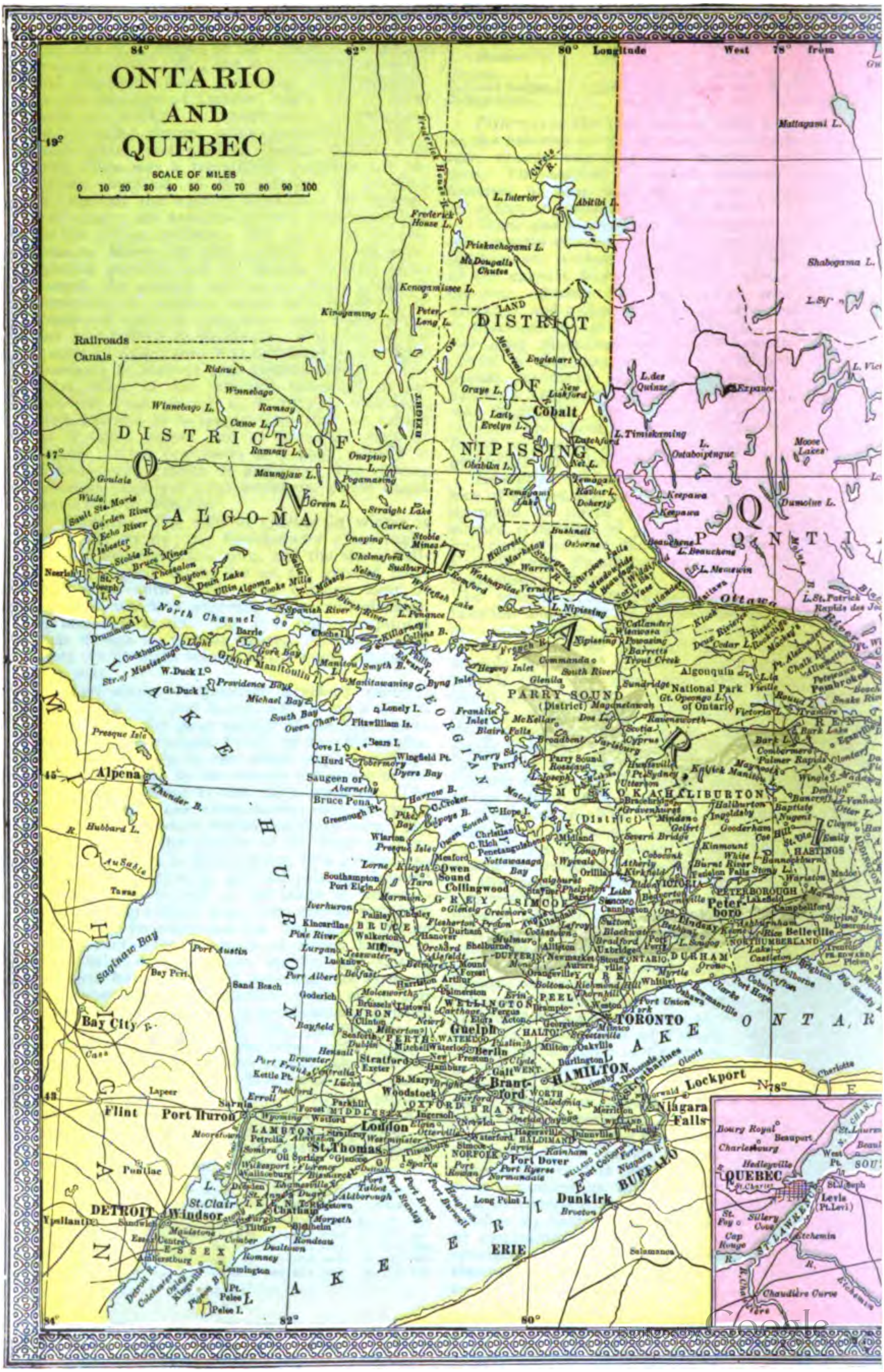
Product	Area, in acres	Total yield, bushels	Total value
Spring wheat........	99,400	1,827,000	$2,187,000
Oats................	1,649,600	48,927,000	21,626,000
Buckwheat..........	69,456	1,851,000	1,229,000
Mixed grains........	131,500	3,508,000	2,133,000
Potatoes............	140,400	21,271,000	9,359,000
Turnips............	31,306	10,159,000	$3,556,000
Hay and fodder......	3,090,800	5,502,000	51,114,000
Fodder corn.........	39,132	357,000	1,703,000

Fisheries.—The total annual yield and value of the fisheries of the province is about $2,000,000; vessels engaged, 800; manned by 6,000 men. The number of vessels engaged in the fisheries in 1901 was 786, having a tonnage of 25,605, and manned by 6,214 men.

Trade and Commerce.—The annual value of the imports entered for home consumption by the province is about $100,000,000 and the value of the exports from the province about $110,000,000. Quebec has more than 400 bank branches, and a clearing house at Montreal with transactions in 1911 of $2,306,783,375. Quebec has 4,905 manufacturing establishments, with capital of $255,000,000, 119,000 employees and annual products worth $320,000,000. The value of Quebec's mineral production in 1910 was $7,323,281. The annual receipts of the province are about $7,000,000. There are published in Quebec 15 daily newspapers and 180 periodicals of other descriptions.

Education.—Educational matters in the province of Quebec are under the control of a superintendent of public instruction assisted by a council consisting of 35 members, and divided into committees for the management of Roman Catholic and Protestant schools, respectively. Compulsory school age is from 5 to 16 years. The schools are maintained partly by local taxation and partly by government grants, and are individually controlled by local boards. There are in the province 5,663 elementary schools, 661 model schools. In the elementary schools there are more than 187,000 Catholic pupils and 31,000 Protestant pupils. The total number of schools, universities and colleges in the province is given at 6,760; teachers, 8,586; pupils, 508,563. Chief among the higher institutions of learning are Laval University at Quebec, and McGill University and the Presbyterian College at Montreal.

Government.—The system of government established in Canada under the Union Act of 1867 is a federal union having a general or central government controlling matters essential to the general development, the permanency, and the union of the whole Dominion, and a number of provincial organizations, each governed by a lieutenant-governor, nominated and removable by the government of the Dominion, and advised by a council responsible to the people's representatives, and with a legislature composed in Quebec of two houses — a council appointed by the Crown, and an elective assembly. The Parliament of Canada consists of a Senate and a House of Commons. The Senate, as at present constituted, has 81 members, 24 of whom are from Quebec. The House of Commons consists at present of 213 members, the basis of representation, fixed under the provisions of the Act of Confederation, being that the province of Quebec is always to have 65 representatives, and each of the other provinces such a number as will give the same proportion of representatives to its population as the number 65 bears to the population of Quebec as ascertained by a decennial census. In the province of Quebec the qualifications for the electoral franchise are ownership or occupancy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LAKE HURON
GEORGIAN BAY
LAKE ERIE
LAKE ONTARIO
MICHIGAN
TORONTO
HAMILTON
London
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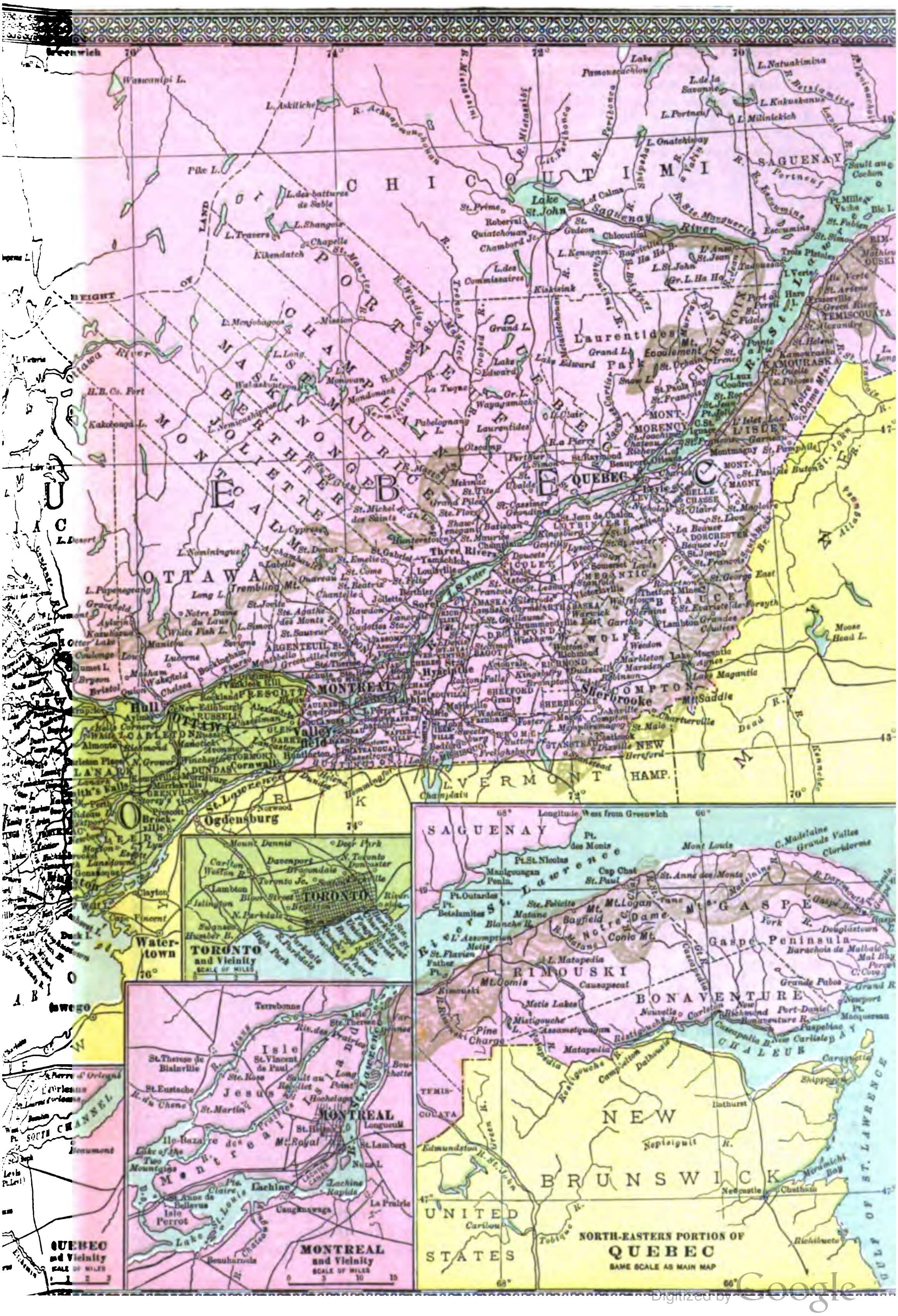
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CHARLEVOIX
MONTMORENCY
L'ISLET
MONTMAGNY
KAMOURASKA
TEMISCOUATA
BELLECHASSE
DORCHESTER
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MEGANTIC
WOLFE
COMPTON
STANSTEAD
SHERBROOKE
RICHMOND
ARTHABASKA
NICOLET
DRUMMOND
SHEFFORD
BROME
PRESCOTT
RUSSELL
CARLETON
LANARK
GRENVILLE
DUNDAS
STORMONT
GLENGARRY
LEEDS
Lake St. John
Saguenay River
Laurentides Park
Three Rivers
QUEBEC
MONTREAL
Ottawa River
Hull
OTTAWA
Sherbrooke
Trembling Mt.
Valleyfield
Cornwall
Brockville
Ogdensburg
Watertown
Oswego
St. Lawrence R.
VERMONT
NEW HAMP.
MAINE
Moose Head L.
Lake Megantic
Lake Memphremagog
Champlain
74°
72°
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TORONTO and Vicinity
SCALE OF MILES
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Isle Jesus
Montreal
Lachine
Longueuil
QUEBEC and Vicinity
SCALE OF MILES
NORTH-EASTERN PORTION OF QUEBEC
SAME SCALE AS MAIN MAP
Longitude West from Greenwich
Gaspe Peninsula
GASPE
RIMOUSKI
BONAVENTURE
Mt. Logan
CHALEUR BAY
NEW BRUNSWICK
UNITED STATES
GULF OF ST. LAWRENCE
68°
66°

of real property; position as teachers or clergymen after five months' domicile in electoral district; income or personal property of specified amount — real, or real and personal, valued at $300, $200, and $100 (fishermen). Income, rentiers, $100; others, $300. Absentees in the United States may vote if they have returned with their families and have resided in an electoral district one month before election. Voting in elections is by ballot. No property qualification is demanded from a member of the Commons, nor is he limited to a residence in the district for which he is elected.

Municipal Institutions.—The municipal organization of the province comprises townships, counties, being rural districts of no definite area, parishes, villages with a population of over 40 families, towns, and cities erected by legislative authority. No definite figure of population is requested. The townships, parishes, towns, and villages are administered by a mayor and councilors; the cities by a mayor, councilors, and aldermen.

Judiciary.—The judiciary of the province consists of appeal (King's Bench), superior, circuit, and district courts. The superior court and King's Bench judges are appointed by the governor-general in council. Appeal can be had from superior courts to King's Bench, and from King's Bench to the supreme court of Canada, presided over by a chief justice and five associate judges. Final appeal, except in criminal cases, lies, by leave, to the judicial committee of the privy council of England. Police magistrates and justices of the peace, appointed by the provincial government, also have their place in the administration of justice.

Crown Lands.—The crown lands of the province not yet settled form an area of nearly 200,000,000 acres, of which about 6,625,000 acres have been surveyed, and are controlled by the government and administered by the minister of crown lands. They are sold at from 20 to 60 cents an acre, and the purchaser is required to take possession of the land within six months of the date of the sale, to occupy it during two years, and to fulfil various other obligations stipulated in the deed of sale.

Population.—The population of the province in 1911 was 2,000,687. Roman Catholics comprised the greater part of the population, which is 80 per cent French and 20 per cent English speaking. Of the French speaking wage-earners, 36 per cent are engaged in agriculture and 24 per cent in manufacturing and mechanical industries. The numerous churches, colleges, and convents of the province attest at every turn the wealth and power of the Church, and the tourist finds the whole land practically parceled out among its faithful, as far as concerns the nomenclature of the settlements and villages.

Twenty miles east of the city of Quebec, on the banks of the Saint Lawrence, is the church of Sainte Anne de Beaupré, more particularly known as La Bonne Sainte Anne, who for two centuries has won fame in Canada for miraculous cures. This historic place rests on a little plateau under the shelter of a lofty mountain of the Laurentides, and consists of a straggling street of wooden houses, with steep roofs and projecting eaves. Here one will see, on the fête of Sainte Anne and at other fixed times, a mass of people from every part of Canada, as well as from the United States. A handsome gray stone church attests the faith of the thousands who in past years have offered their supplications at the shrine of La Bonne Sainte Anne. Piles of crutches are deposited in every available corner, as so many votive offerings from the countless cripples who have been cured or relieved. The relic through which all the cures are said to be effected consists of a part of the finger-bone of Sainte Anne, which was sent in 1668 by the Chapter of Carcassone to Monseigneur de Laval.

The Country Life.—The situation of many of the villages of Quebec is exceedingly picturesque when they nestle in some nook by the side of river or bay, or overlook from some hill a noble panorama of land and water. The spire of the stone church rises generally from the midst of the houses, always making the most conspicuous object in the surrounding landscape. The houses are, for the most part, built of wood. The roofs are often curved, with projecting eaves, which afford a sort of veranda, under which the family sit in summer evenings. Some of the more pretentious structures, especially the inns, have balconies running across the upper story. Many of the barns and outhouses have thatched roofs, which are never seen in any other part of Canada. The interiors are very plainly furnished, in many cases with chairs and tables of native manufacture. A high iron stove is the most important feature of every dwelling in a country where the cold of winter is so extreme. Whitewash is freely used inside and outside, and there is, on the whole, an air of cleanliness and comfort in the humblest cottage. No class of the population of Canada is more orderly or less disposed to crime. Early marriages have always been encouraged by the priests, and large families are the rule in the villages. The temperate habits of the people make them valuable employees in mills and manufactories of all kinds, and until a recent period there was a steady exodus from the province to the manufacturing towns of New England. A large proportion of the men employed in the lumbering industry of Canada is also drawn from the province of Quebec. In commercial and financial enterprises, however, the French Canadians cannot compete with their fellow citizens of British origin, who practically control the great commercial undertakings and banking institutions of Quebec, especially in Montreal. But they are remarkably progressing in that line. Nor, as a rule, could they compare formerly with the English population as agriculturists. But they have largely improved their methods of farming, and they have established in every parish butter and cheese factories. The French population also had less enterprise and less disposition to innovations. But they do adopt new machines and improved agricultural implements like the people of the other provinces of Canada.

Literature.—In times past there was no native literature, and little general culture, except in small select circles at Quebec and at Montreal; but during the past half-century, with the increase of population, the establishment of colleges and universities, the dissemination throughout of classical education, and the development of self-government, the French Canadians have created for themselves a literature which shows that they inherit much of the spirituality and brilliancy of their race. The histories and poems have attracted much attention in France, and some of their literary works have been awarded prizes by the French Academy. In history mention should be made of the names Garneau, Ferland, Sulte, Tassé, Turcotte, Dionne, Casgrain, Gosselin, Le Moine, Gagnon, Myrand, etc:; in poetry, Cremazie, Chauveau, Frechette, Poisson, Lemay, Chapman, and many others; in science, Hamel, Laflamme, De Foville, etc. In art some progress has been made, and young men go to the Paris schools from time to time. The only sculptor of original merit that Canada has yet produced is Hébert, a native of Quebec, whose statues of eminent Canadians stand in several places. Science has not made as much progress as belles-lettres and history, though Laval University has among its professors men who have done creditable work in mathematics, geology, chemistry, and physics. In romance, however, little has been done, except by Marmette, Lemay, and a few others.

History.—Jacques Cartier discovered and explored the Saint Lawrence in 1535, but it was not until 1608 that Samuel de Champlain founded the present city of Quebec, which, at the end of 12 years, had a population of only 60 persons. The Recollets were the first missionaries. The Jesuits came to the settlement in 1634, and thereafter played a leading part in its history. Montreal was founded in 1642 by Maisonneuve; but for many years as an agricultural or commercial settlement New France, as it was called, remained a failure, its only trade being the fur trade. A change came under Louis XIV., when a systematic effort began to make the colony the starting point of a French and Catholic empire which should embrace the whole of the continent. The result of this policy was a century-long contest between the two races, which began in 1689 with the second advent of Count de Frontenac as governor of New France, and ended in 1759 with the capture of Quebec by a British army under Wolfe. The capitulation of Montreal in 1760 completed the English conquest of Canada, which, with all its dependencies, was in 1763 formally ceded to the British crown.

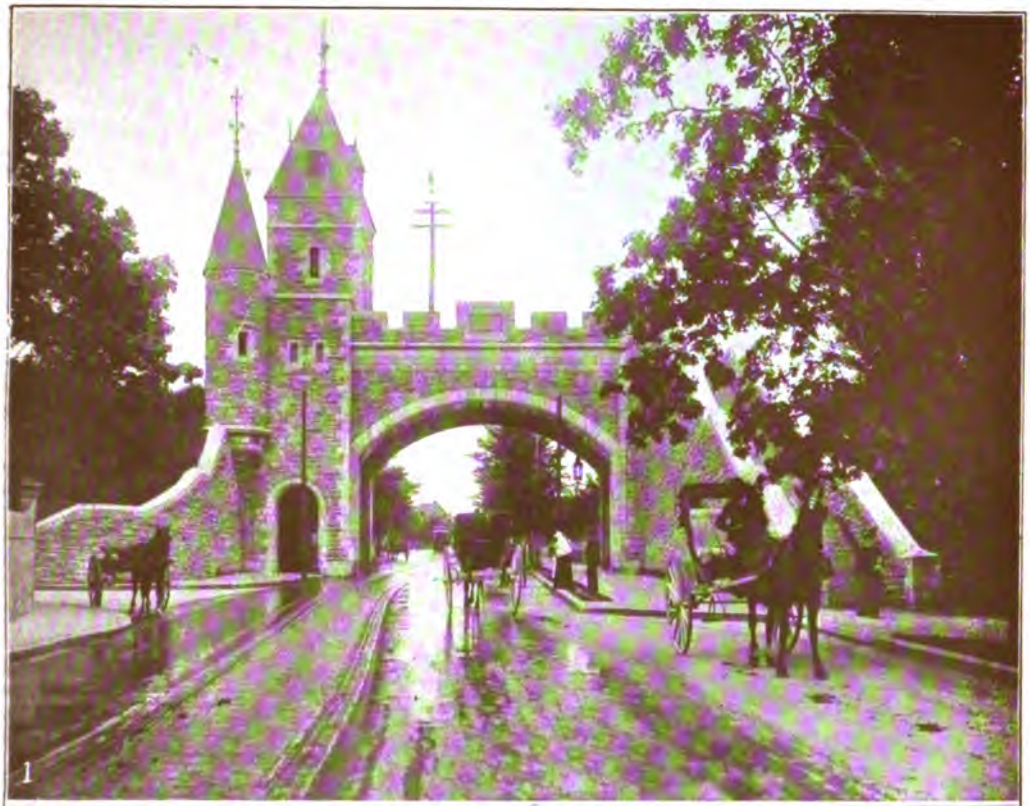
The policy of the conquerors toward New France was, from the appointment of Gen. Murray, a liberal one, and in 1774 took definite form in what was known as the Quebec Act, by which the British Parliament assured the French Canadians the free exercise of their religion, the enjoyment of their civil rights, and the protection of their own civil laws and customs. The act also annexed larger territories to the province of Quebec, and provided for a governing council partly composed of Catholics, and for the administration of the criminal laws as in use in England. There was, however, constant strife between the conquering and the conquered race, the object of which was to amalgamate the two races, and to put an end to it Parliament in 1791 divided Canada into two provinces — Lower Canada, or Quebec, for the French, and Upper Canada (now Ontario) for the British, many of whom had fled thence from the United States at the close of the Revolutionary War. Each province was to have, besides the governor who represented the Crown, a legislative council nominated by the Crown, and an assembly elected by the people for four years. But the two races were not separated by the division of the province, and in 1841, after a long and stormy agitation, a reunion of the provinces was effected under the name of the Province of Canada, and with it the establishment of responsible government. The legislature consisted of a council and assembly, each province being represented in the assembly by 42 members, 84 in all, elected by the people; and the council numbered 20 members, appointed by the Crown. This arrangement lasted until 1867, when it gave way to a union of the provinces of British North America. The way for confederation was cleared by a convention of representatives of all the provinces, held in Quebec, in October 1864, which unanimously adopted a set of resolutions embodying the conditions on which the provinces, through their delegates, agreed to a federal union. These resolutions were duly laid before the various legislatures and adopted in the shape of addresses to the Queen, whose sanction was necessary to embody the wishes of the provinces in an imperial statute; and in February 1867 the British North America Act was passed by Parliament. On 1 July of the same year the union of the provinces of Canada, Nova Scotia, and New Brunswick was proclaimed under the name of the Dominion of Canada, the names of Upper and Lower Canada being changed at the same time to Ontario and Quebec.

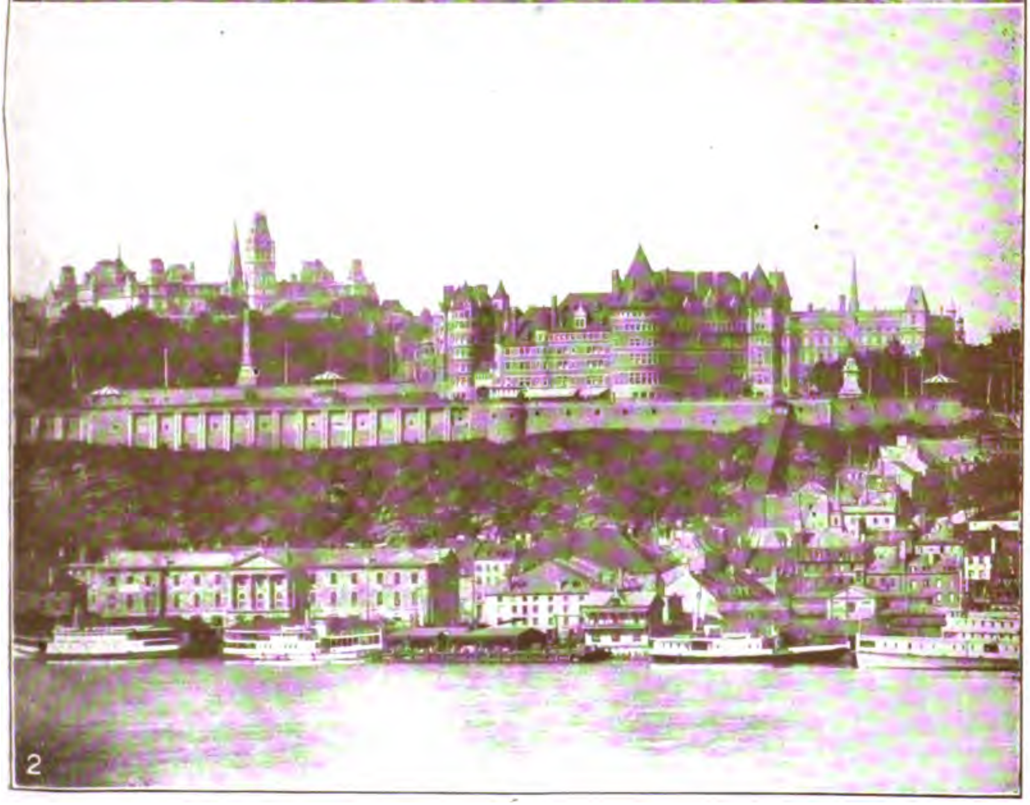
Consult: Parkman, 'France and England in North America'; Kingsford, 'History of Canada'; Smith, 'Canada and the Canadian Question'; Garneau, 'History of Canada'; and Turcotte, 'Le Canada sous l'Union.'

A. B. ROUTHIER,
Chief Justice Superior Court for the Province of Quebec.

Quebec, founded by Samuel Champlain in 1608, is the seat of the Provincial Government. It is situated on the northeastern end of a narrow promontory, which is bounded to the southward by the River Saint Lawrence, and to the northward by the valley of the St. Charles. The cliffs on the St. Lawrence side run up the river for many miles, and average between 200 and 300 feet in height. The earliest buildings were constructed along the narrow shore at the foot of Cape Diamond, and gradually extended to what is now the Lower Town. In the course of time Champlain transferred his residence to the summit of the rock, and soon other buildings arose which marked the beginnings of the Upper Town. In a few places in the Lower Town a part of the river bed has been reclaimed, particularly near the old palace of the Intendants; but with these exceptions the streets follow the original plan. Winding roads, cut out of the rock, and flights of steps, lead from the Lower to the Upper Town, the streets of which bear the names originally given to them. Quebec claims the distinction of being the one walled city of the north, and although the march of progress has introduced many innovations, it has been powerless to destroy the impress of the founder. At the time of the death of Champlain, in 1635, the entire population of Quebec was only 80 persons. But shortly after, as a result of the circulation of the «Relations» of the Jesuits in the mother country, an effort was made to colonize New France. The first fruits of this movement were the establishment of the Ursuline Convent and the Hotel Dieu, in 1639.

QUEBEC.





1. St. Louis Gate and the Grand Allee. 2. The Chateaux Frontenac, from Levis

These two institutions, which have ever since exercised a beneficent influence, were founded by the zeal of two noble women, Madame de la Peltrie, and Madame d'Aiguillon, whose names are consecrated in the pages of Canadian history. The Ursuline Convent has continued to be the centre of education for the girls of Quebec, both French and English. In this institution, the Old World and the New run side by side. The rule of the order is the same as in 1639. In the nave of the convent chapel repose the remains of the Marquis de Montcalm; and in the Chapel of the Saints, through all the startling changes of two centuries, the Votive Lamp, first trimmed by Marie Repentigny in the days of the French régime, is still kept steadfastly burning. The Seminary of Quebec, founded in 1668, is another institution in which the customs of the Old World are preserved. From the seminary sprang the famous Laval University, the chief seat of learning in the province for the French population.

From the earliest times Quebec has been fortified. In 1535, Jacques Cartier built a rude fort at the mouth of the river Lairet, and in 1608 the «Habitation» constructed near the site of the present Champlain Market, was mounted with cannon to protect the inhabitants against the incursions of the Indians. Twenty years after a fort was erected on the crest of the rock, which served as a residence for the invader Kertk until 1632. Frontenac put into execution the first scheme for enclosing the town with a wall, but like all the French works of defense, the profit of the contractor was of more importance than the solidity of the workmanship. In 1720, a new scheme was undertaken. Large sums of money were expended from year to year, but when Wolfe came before Quebec in 1759, the foot of rotten walls could be seen 500 yards off. After the battle of the Plains, temporary works were constructed in front of the old walls. In 1783 a temporary citadel was commenced beyond the line of fortification, and the remains of these works, still visible, are erroneously referred to in local guide books and maps, as of French origin. In 1823 the British Government undertook a comprehensive scheme of defense, the main parts of which are in excellent repair to-day. The picturesque old gates have been demolished, and in two instances, arches in keeping with the walls, have replaced them, and the Martello Towers, overlooking the Plains of Abraham, stand as originally built. The Fortress of Quebec comprises the citadel on Cape Diamond, where the governor general's quarters are situated, the town lines, and the forts on Levis Heights. The citadel is garrisoned by the Royal Canadian Artillery.

Quebec has nine parish churches belonging to the Catholics, four others in the charge of chaplains, and thirteen chapels attached to religious communities, open to the public. The Church of England is represented by the English Cathedral, and six churches, while the Methodists, the Presbyterians, and the Baptists, have each separate places of worship. The first parish church was erected in 1633 under the name of Notre Dame de la Recouvrance; but it was destroyed in 1640. In 1647 the French Cathedral was commenced under the name of Notre Dame de la Paix, in commemoration of the peace concluded with the Iroquois. It was opened in 1650. The pillars of the present church date from 1647, the Towers from 1684, and the remainder of the building from 1745. The paintings in the Cathedral, brought from France, are very valuable, and there are many costly vestments of an early date. Notre Dame des Victoires, in the Lower Town, was commenced in 1688 under the name of Notre Dame de la Victoire. After Phips besieged Quebec in 1690, a pilgrimage to the church was organized, and in 1711, on the destruction of Walker's fleet off Egg Island, the name of Notre Dame de la Victoire was changed to Notre Dame des Victoires. During the siege of Quebec in 1759, only the walls were left standing. Of the modern Catholic churches the Franciscan's is the most beautiful. It was built for the perpetual adoration of the Blessed Sacrament.

After the Treaty of Paris in 1763, English services were held by the Protestants in the Church of the Recollets. The drum was beaten at half past ten for the Mass of the Recollets, at the conclusion of which the fathers tolled the bell for the English service. The English Cathedral, situated on the site of the Recollet Church, was commenced in 1804. The paintings in the Archbishop's Palace, and in the Ursuline Convent and Laval University, are amongst the most valuable in Canada. In the Governor's Garden is a monument which always appeals to strangers. It is a plain granite column. On one side it bears the name of Wolfe, and on the other the name of Montcalm,» and on the base this simple inscription:

Mortem virtus communem
Famam Historia
Monumentum Posteritas
Dedit.

It is the only instance on this continent of a common monument to the victor and the vanquished. Near the jail is the monument to Wolfe, with its inscription «Here Died Wolfe Victorious,» and a little farther on, along the Ste. Foy Road, is the column to the memory of the French who fell in their endeavor to retake Quebec in 1760. The name of the English general, Murray, is also prominent on this column. These monuments of stone are more eloquent than words of the harmony existing between two races, mingling with each other, and still preserving their own laws, their language and their religion. In the Upper and Lower Town markets may be witnessed scenes typical of French Canadian habitant life, and even in the streets through which the electric cars run we may trace, at all times, the features of the French régime. The boys of the Seminary still wear the long blue coat piped with white, with green sashes, as they did 200 years ago. The nuns passing to and fro in their prescribed costumes; the priests in their cassocks, the habitants in their old-fashioned vehicles or rude sleighs, look out of place in the 20th century; and yet the people of Quebec would not welcome any change. The city, however, keeps pace with the times in other respects. The streets are well paved, well lighted, always clean. All the waste places possible are converted into small gardens, and there is an excellent civic administration. The hotel accommodation, especially since the construction of the Château Frontenac, is the best in Canada. The Parliament buildings and grounds, the city-hall, the court-house and other public buildings, are better than in the larger cities of Canada, and yet there is still so much which belongs to a by-gone age. According to the census of 1901, the population of Quebec is 68,840, a very large proportion of which is composed of French.

Most of the English reside in the Upper Town, although there is no marked division. The Grande Allée is the principal thoroughfare, and contains many fine dwellings. At one time the lumber trade flourished, and as large fortunes were amassed the wealthy merchants and traders built country seats along the Sillery Road; but they are now mostly deserted. Ship building was also a great industry for many years, as very large vessels were built there, but nothing now remains. The leather and shoe trade still give employment to thousands. The commercial and financial institutions are controlled to a large extent by the English. The Lower Town is principally devoted to business, and the suburbs of Saint Roch and Saint Sauveur to manufacture and the dwellings of the working classes. The small arms and the ammunition for the militia are manufactured in Quebec. The port of Quebec is always active in season, but Montreal has absorbed a great deal of the commerce. The bridge which is being built across the Saint Lawrence will bring the grain from all quarters to Quebec, and its future commercial life may assume large proportions. As the seat of government, it will always retain a prominent place, and in its immediate vicinity there are so many places of picturesque and historic interest: Wolfe's Cove; the place where the gallant Montgomery fell in 1775; the Heights of Levis; the Island of Orleans; the Village of Beauport, with Montcalm's headquarters; Indian Lorette; the Falls of Montmorency, with Wolfe's House; the Shrine of Ste. Anne, and the numerous places which may be reached by the C. P. R., the G. T. R., the Intercolonial Ry., the Great Northern, the Quebec and Lake Saint John, and the boats of the Richelieu and Ontario Navigation Co. But the perpetual charm of Quebec, apart from its magnificent situation, lies in the fact that it is the cradle of New France; that upon its lofty rock a drama was fought which decided the fate of a continent; that from its institutions, scarcely altered by the flight of three centuries, men went forth to rescue for civilization an untamed wilderness, and paved the way for the great Republic of the United States.

A. G. Doughty,
Author of 'Quebec Under Two Flags.'

Quebec Act, the administrative measure passed by the British Parliament in 1774, for the purpose of adding the regions extending to the Ohio and Mississippi over which the French had exercised authority, to the province of Quebec, which had been limited by the Proclamation of 1763 to an area of about 100,000 square miles along the central Saint Lawrence. The Act established also the body of the French customary law as the permanent civil code of the region, the introduction of English civil law among the French-speaking inhabitants having been found impracticable; it admitted also to a partial franchise the Roman Catholic population, guaranteeing them freedom of public worship, confirming them in the possession of their ancient churches and revenues, but withholding from them representative institutions, authority over this vast territory being vested in a council appointed by the executive power of Great Britain.

The Act, which had for its main motives the welfare of the French Canadians and the security and unhampered progress of the colonies and of colonial trade, was viewed with indifference by the Canadians, was unpopular in England, aroused the indignation of the older American colonies, and had considerable influence in directing the early course of the Revolution. To it the Declaration of Independence refers as follows:

"Abolishing the free system of English laws in a neighboring province, establishing therein an arbitrary government, and enlarging its boundaries so as to render it at once an example and fit instrument for introducing the same absolute rule in these colonies." For opposing views on the measure, consult: Coffin, 'The Quebec Act and the American Revolution' in *The Yale Review* (1895); and Bancroft, 'History of the United States,' Vol. IV., chap. v. (1884).

Quebec, Battle of. See Colonial Wars in America.

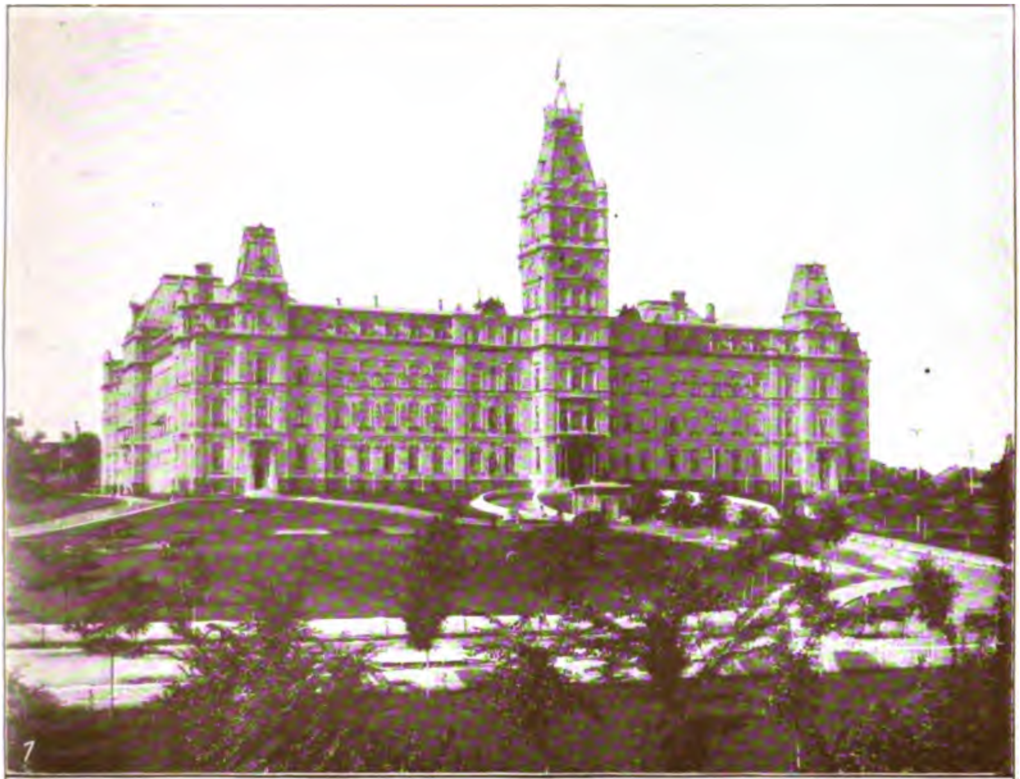
Quebracho, kĕ-brä'chō, the name given to several trees of different genera, but with similar qualities, indigenous to South America, valuable alike for their wood and their bark. The red quebracho (*Loxopterygium lorentii*, family *Anacardiaceæ*) is very hard, but splits easily. The bark and wood are used in tanning. The white quebracho (*Aspidosperma quebracho*) is used for wood-engraving. Its bark contains an alkaloid (quebrachin) and is used therapeutically as a remedy for asthma, being employed as a decoction and a tincture. Its action is to lower the action of the heart without harmful result.

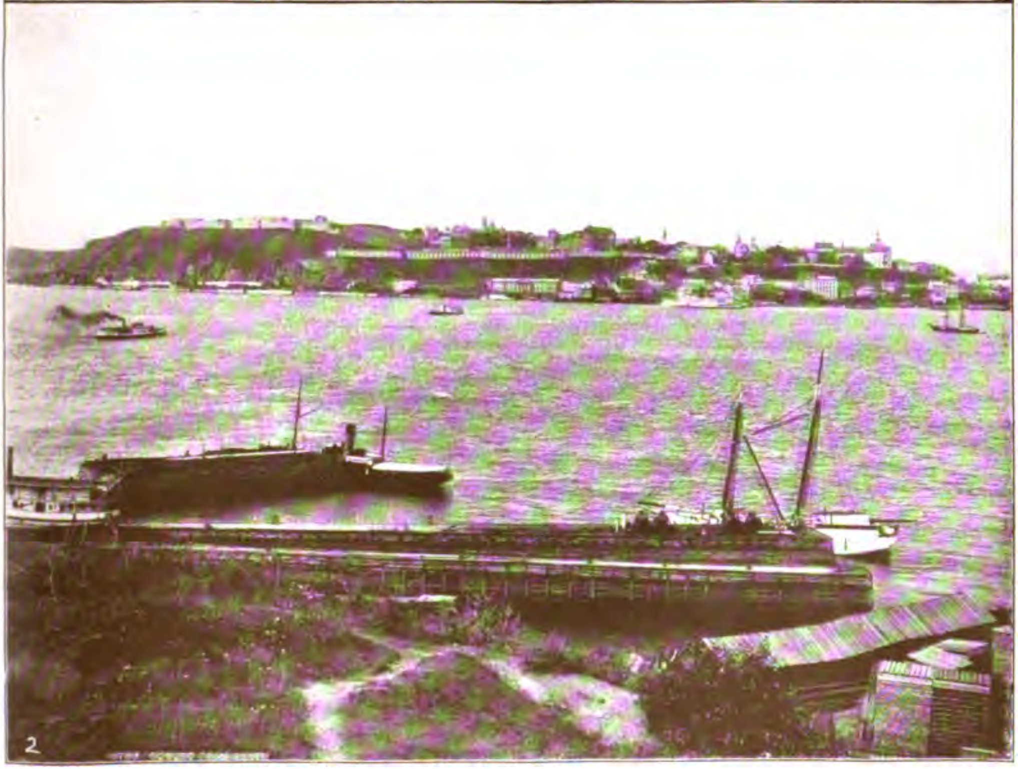
Quechua, kä'chwạ. See Quichua.

Quedah, kä'dạ, or **Kedah,** Malay Peninsula, on the west coast of the peninsula, but belonging to Siam. It is bounded on the south by the British province of Wellesley and the province of Perak. Area, 3,600 square miles. Pop. about 32,500.

Queen, the wife of a king, or the female sovereign of a kingdom. In Britain she is either merely a queen-consort, the king's wife, and his subject, not his equal, on an equal footing, save as provided by law, with the rest of his subjects; or she is a *queen-regent*, regnant, or sovereign, holding the crown in her own right, as did Elizabeth or Victoria. The *queen-dowager*, widow of the king, retains most of the privileges pertaining to a queen-consort. It is high treason to compass or imagine the death of a queen-consort, or to violate her person; and if the consort is consenting, she is equally guilty. Under the constitution of Prussia, Sweden, Belgium, and other European countries a woman cannot be queen-regent.

Queen Adelaide Archipelago, belonging to Chile, at the west entrance to the Strait of Magellan; separated from the mainland by Smyth Channel. The islands are mountainous and present rugged faces to the sea. The summits of some are snow-capped during the year:





1. Parliament Buildings 2. City of Quebec from Levis

but the vegetation at the base is varied and, for a short season luxuriant.

Queen Anne Style. See RENAISSANCE.

Queen Anne's Bounty, a fund established for the enlargement of the incomes of the holders of the poorer incumbencies in the Established Church of England, and to aid incumbents in rebuilding parsonages by granting advances of money. It was created by royal charter of Queen Anne, confirmed by act of the parliament, by which the first fruits (the whole of the first year's profits) of all spiritual preferments, and the tenth part of the annual profits of the same — both of which, prior to the reign of Henry VIII. had been paid into the papal treasury, but were then annexed to the crown — are set aside to form this perpetual fund. The fund is administered by a board of governors consisting of high ecclesiastical dignitaries, the speaker of the house of commons, privy councillors, chancellors of the universities, etc. It amounts to over $25,000,000, and the annual grants to over $75,000. To encourage private benefaction, the board of governors may give $1,000 to incumbencies of not exceeding $225 a year where an equal or greater sum is voluntarily contributed.

Queen Anne's Pocket-Melon. See MELONS.

Queen Anne's War. See COLONIAL WARS IN AMERICA.

Queen of the Antilles, a name given to the island of Cuba on account of its superior natural advantages.

Queen Charlotte Islands, a group off the coast of Canada, belonging to the Province f British Columbia; about 100 miles from the mainland and 135 miles northwest of Vancouver Island. Area, 5,100 square miles. The largest islands are Graham and Moresby, each about 160 miles long and 70 miles wide. The surface of Graham is rolling land; but the other islands are rugged and mountainous. Dense forests and a luxuriant growth of small plants cover the islands. Copper, anthracite coal, iron ore and gold-bearing quartz are found here; fishing is the chief occupation. The inhabitants are mostly Indians.

Queen Charlotte Sound, the body of water which separates Vancouver Island (q.v.), on the north, from the mainland of Canada. It is the first, on the north, of a series of inlets, or channels, which lie between Vancouver and other islands and the mainland.

Queen City, or **Queen of the West,** names applied to Cincinnati, Ohio, on account of its commercial importance, at a time when it was larger than Chicago and Saint Louis.

Queen City of the Golden Gate, a name given to San Francisco on account of the name of the strait north of the city, and also that the city was practically the gate or entrance to the gold fields of California.

Queen City of the Lakes, a name given to Buffalo, N. Y., on account of its commercial importance and its commanding position on the Great Lakes.

Queen Conch, a large West Indian gastropod (*Cassis cameo*). See CONCH.

Queen of the Eastern Archipelago, the island of Java; so called on account of its salubrious climate, picturesque scenery, and fertile soil. It is the seat of the Netherlands power in the East. See JAVA.

Queen Esther. See MONTOUR, ESTHER.

Queen-of-the-Meadow, or **Quaker-lady,** a spiræa. See MEADOW-SWEET.

Queen of the Plains, a name applied to Denver, Colo., which rests on an eminence on the western border of the Great Plain, and seems to overlook the vast region of plain-land stretching off to the east.

Queen's Bench. See COURT.

Queen's College, Cambridge, England, founded in 1448 by Margaret of Anjou, queen of Henry VI., and again in 1465 by Elizabeth, queen of Edward IV., is administered by a president and 13 foundation fellows. A fixed proportion of the revenues of the college is paid to a scholarship fund. There are nine church livings in the gift of the college, and one in that of the president. There are in addition four exhibitions named after their founders, and the president distributes $650 per annum in grants to deserving students of limited means. The college buildings are among the most interesting in the university, and include four courts of small size. In a tower in the pump-court are the rooms inhabited by Erasmus (1506). John Fisher, Thomas Fuller, and Bishop Pearson were members of the college.

Queen's College, London, England, established for women in 1848, was incorporated by royal charter in 1853. It provides for the higher education of women, first by a liberal school training, and subsequently by a six years' course of college education.

Queen's College, Oxford, England, was founded in 1340 by Robert Eglesfield, chaplain to Philippa, queen of Edward III., for a provost and 12 scholars. The college now consists of a provost, from 14 to 16 fellows, about 25 scholars, and two Bible-clerks. Six of the scholarships, annual value $400, are called Eglesfield scholarships, and are awarded to natives of Cumberland and Westmoreland. There is also a scholarship called the Jodrell scholarship, of the annual value of $450 and tenable for four years; and a considerable number of other exhibitions. The college presents to 23 church-livings. The college buildings are of the 17th century; the hall was designed by Sir Christopher Wren. Wyclif, Edward the Black Prince, Henry V., Addison, Bentham, Jeffrey, Mitford and Wycherley are numbered among its distinguished alumni.

Queen's Colleges, Ireland, three in number, are situated at Belfast, Cork, and Galway, and were chartered in 1849 in pursuance of an act of parliament passed in 1845, granting $500,000 out of the consolidated fund for their establishment. The colleges were opened in 1850, being connected with Queen's University, then also instituted as a degree-conferring body. The corporate body of each college consists of the president and professors, and the general government and administration are vested in a council consisting of the president and six members, elected by the professors from among themselves. The number of students attending during the session of 1901 was 627.

Students of the Queen's Colleges in Ireland may obtain degrees in arts, medicine, and law from the Royal University of Ireland (q.v.) by observing the course of studies prescribed by that body, and passing the requisite examination. This university was founded in pursuance of the provisions of the University Education (Ireland) Act, 1879, and has now superseded the Queen's University in Ireland.

Queen's Metal. See Britannia Metal.

Queen's Pigeon, a magnificent ground pigeon (*Goura Victoriæ*), inhabiting the islands of the Indian Ocean, named after Queen Victoria. See Goura.

Queen's University, Kingston, Canada. The Royal Charter of Queen's University dates back to 1841. In 1838 steps were taken by the Synod of the Presbyterian Church to found a college at Kingston, Ontario, for the training of young men for the learned professions, including the work of the ministry. The beginnings, as usual with colleges, were small. The first classes with ten students were opened in March, 1842, with Dr. Liddell as principal. Funds were provided in part from grants from the Presbyterian Church of Scotland, and from the Canadian government, in part from the liberal subscriptions of friends of the young and growing university. Owing to the lack of good schools in the province, it was found necessary to establish a preparatory school in connection with the college. In spite of straightened circumstances and many obstacles progress was steady, and financial difficulties were overcome by the energy and courage of principal and friends.

Three times have appeals been successfully made to the public for the endowment fund; the first campaign under Principal Snodgrass took place at a time of great depression, and tided the college over a serious crisis. A second appeal was made by his successor, Principal Grant, in 1878–9, with brilliant success, and in 1881 a new building, an enlarged staff, and a great increase of students was the immediate result. Again in 1887 an effort was successfully made to raise the sum of $250,000, which was called, in honor of the Queen's Jubilee, the Queen's Jubilee Fund. The twenty-five years of Dr. Grant's principalship were marked by extraordinary growth and development on every side of college life. Himself a tireless worker and a born leader of men, he succeeded in infusing his own enthusiasm into all around him.

At the time of the Federation of Colleges in Toronto Queen's was urged to join, but the proposal was decidedly negatived by the friends of Queen's, and events have fully justified their decision.

The medical faculty of Queen's was established in 1854. It was reorganized in 1865 as the Royal College of Physicians and Surgeons in affiliation with the university. In 1891 the original status was resumed. The number of students last year enrolled was 216. Queen's led the way in Canada in co-education. As early as 1870 special classes in English and other subjects were formed for women, but the academic career leading to a degree was not thrown open to them till 1878–9. In 1880, co-education was extended to the medical course, but in 1883 a separate Women's Medical College was opened and affiliated with Queen's. In 1894, similar facilities being offered in Toronto and other places, this college was closed. Meanwhile the extension of Queen's continued. 1891 saw the opening of the Carruthers Science Hall and of the School of Mines, the latter under government support, by whom the splendid building for physics and geology has lately been added. At the time of Principal Grant's death, in 1902, three new buildings were rapidly approaching completion. Since that time a magnificent Convocation Hall has been erected by the students and alumni to his memory. It is called Grant Hall. The group of college buildings at present consists of two arts buildings, with the Grant Hall, the engineering building, the physics and geology building, the Carruthers Science Hall, and the medical building.

The number of students registered in 1903, in all faculties, was about a thousand. Each session tells of increase. The government of the student body is largely carried on by the Alma Mater Society, which was formed in 1859–60. It has its own officers (taken from the students) and regular meetings, and has its official organ in the 'Queen's College Journal,' published entirely by students. The annual alumni conference brings many of the sons of Queen's back for a week's intercourse and renewal of old ties. The library, which is in the main arts building, contains about forty thousand volumes, including many valuable donations and collections. The curriculum of this university includes the following courses: The Arts Course, leading to the degrees of B.A. and M.A., D.Sc., and Ph.D., embraces classical literature, modern and oriental languages, English, history, mental and moral philosophy, political science, mathematics, physics, chemistry, mineralogy, geology, assaying, metallurgy, botany, and animal biology. The Law Course, leading to the degree of LL.B. The Theological Course, leading to the degree of B.D. The Medical Course, leading to the degree of M.D. and C.M. The Science Course, leading to the degree of B.Sc. and M.E.

Geo. Y. Chown,
Registrar of the University.

Queensberry, kwĕnz'bĕr-ĭ, **John Sholto Douglas,** 8th Marquis of, English sporting character: b. England 20 July 1844; d. London 31 Jan. 1900. He served in the navy when a youth, and in the army from 1859 to 1864. His life was marked by much eccentricity. He was one of the founders of the Amateur Athletic Club in 1860, and was a recognized authority on boxing, and part author in 1867 of the prize-ring rules which bear his name. (See Pugilism.) He sat in the House of Lords as a Scottish representative peer in 1872–80. In 1881 he published 'The Spirit of the Matterhorn,' a meditation in blank verse. He also came into prominence as a supporter of secularism, and as a defender of Charles Bradlaugh (q.v.), in 1882 creating a scene in a London theatre by rising in his seat and denouncing as "an abominable caricature" the imaginary free-thinker in Tennyson's 'Promise of May.' He was instrumental in effecting the imprisonment of Oscar Wilde (q.v.) in 1895, by defending the libel action brought against him, on the grounds that what he had published was «justifiable and for the public benefit.»

Queensberry, William Douglas, 4TH DUKE OF, British sportsman: b. 1724; d. London, England, 23 Dec. 1810. He was devoted to horse-racing, and was familiarly known as «Old Q.» He was vice-admiral of Scotland in 1767–76 and was then first lord of the police until the office was abolished in 1782. He succeeded to the dukedom in 1778 and was created a British peer in 1786. In 1789 he was removed from his office of gentleman of the bedchamber and held no further office. He was notorious for his excesses and was satirized by Robert Burns in 'The Laddies by the Banks o' Nith,' and in an 'Epistle to Mr. Graham of Fintrie.' Wordsworth addressed him in a sonnet as «Degenerate Douglas,» and he was the original of the Earl of March in Thackeray's 'Virginians.'

Queensberry Plot, a presumed Scottish Jacobite conspiracy, so called owing to the connivance, in 1703, of the Proto-rebel James Douglas, second duke of Queensberry, with the intrigues of Simon Fraser, Lord Lovat (q.v.), to involve their common enemy, the Duke of Atholl, in a supposed conspiracy against Queen Anne. Atholl discovered the sham plot and revealed it to the queen. Queensberry, who had been a tool of Fraser, was compelled in consequence to resign his offices.

Queensland, Australia, a state of the Commonwealth, prior to 1901 a colony. It occupies the northeastern portion of the continent, north of New South Wales and South Australia, and east of the latter. The land boundaries are mostly artificial, the meridians of 138° and 141° east, and the parallels of 29° and 26° south; on the east it has the Pacific, on the north the Gulf of Carpentaria. The most northern part of it, forming York Peninsula, extends to Torres Strait, and a considerable portion is within the tropics. It has an area of about 668,497 square miles, and is divided into twelve large districts (besides smaller divisions), namely, Moreton, Darling Downs, Burnett, Port Curtis, Maranoa, Leichhardt, Kennedy, Mitchell, Warrego, Gregory, Burke, and Cook. Besides the capital of the state, Brisbane, the other important towns are Ipswich, Rockhampton, Toowoomba, Townsville, Mackay, Maryborough, Gympie, Bundaberg, Charters Towers, Normanton, Cooktown, and Somerset.

Topography.— A series of parallel ranges of mountains traverses the State from north to south near the coast, among the numerous local names being Cook Range, Razorback Range, Dawes Range, and Glasshouse Mountains. The Dividing and M'Pherson Ranges run from the head of the Dumaresq River in the south eastward to the coast. There is a long range in the interior running east and west, and forming a watershed between rivers flowing north and those flowing south. The peak of highest elevation is Wooroonooran in a spur of the Coast Range known as the Bellenden Ker Range. Its elevation is 5,400 feet. The coast is indented with numerous inlets, bays and harbors, some of the chief being: Moreton Bay, Hervey Bay, Port Curtis, Keppel Bay, Broad Sound, Repulse Bay, Halifax Bay, Rockingham Bay, Princess Charlotte Bay. Among the numerous islands along the coast are: Stradbroke, Moreton, and Bribie, at Moreton Bay; Fraser or Great Sandy Island, Curtis, Whitsunday, Hinchinbrook, all off the east coast; Prince of Wales, Banks, Thursday, and others in Torres Strait; and the Wellesley Islands, in the Gulf of Carpentaria. Parallel to the east coast, and at no great distance, runs the Great Barrier Reef.

Hydrography.— There are four great river-systems: (1) rivers draining to the Pacific coast, the chief being the Burnett, the Fitzroy, the Burdekin, and the Brisbane, the last entering Moreton Bay, and having Brisbane, the capital, near its mouth; (2) those draining to the Darling, comprising the Macintyre, the Condamine or Balonne, and the Warrego; (3) those draining to the Gulf of Carpentaria, among them being the Flinders, the Leichhardt, the Albert, the Nicholson, the Gilbert, the Mitchell; (4) those flowing into the interior, the chief being the Victoria or Barcoo, which enters Lake Eyre in South Australia as Cooper's Creek, the Herbert, and the Diamantina or Mueller.

Geology and Mineral Resources.— The Cretaceous system is extensively developed in the west and northwest, covering an area of about 200,000 square miles. Tertiary strata occur along the coast of the Gulf of Carpentaria and elsewhere, and occupy a considerable area. The Desert or Eolian Sandstone, which renders extensive tracts barren and almost uninhabitable, is variously classed as Upper Cretaceous or Tertiary. Palæozoic formations also cover a large part of the country, especially along the eastern coast. About 14,000 square miles are Carboniferous, and some 40,000 of Devonian age, and the Cambrian and Silurian also occur. Mesozoic formations older than the Cretaceous are well developed in some places. Granitic rocks are very extensively developed in the east coast districts, and they have been estimated to occupy about 100,000 square miles. More than 30,000 square miles are covered by volcanic rocks. Gold was discovered about 1858, and there are now more than 25 gold-fields in the state, among them being Gympie (near Brisbane), Charters Towers (on the Burdekin), Cape River, Croydon, Cloncurry, and Jordan Creek. The annual production exceeds $12,500,000. Other minerals of importance are copper, tin, and coal, but antimony, silver, lead, bismuth, manganese, plumbago, asbestos, and precious stones are also obtained. Bluestone, freestone, granite, and other rocks are quarried.

Climate.— The climate is healthful and the temperature comparatively equable. The mean temperature at Brisbane is 69°, the extreme range being from 35° to 106°. In the more northern parts the climate is tropical. The rainfall in the interior is scanty and variable; the mean at Brisbane is about 35 inches. In some parts it is now supplemented by means of artesian wells.

Forestry, Fauna, etc.— The state possesses various kinds of valuable timber, such as the red cedar, the Moreton Bay pine, the cypress pine, and several species of eucalyptus. Some of the grasses are valuable as fodder plants. There are several good indigenous fruits. The animals and plants are similar to those of the rest of

Australia. Crocodiles are found in some of the northern rivers. Pearl-fishing is extensively carried on in the extreme north, and the bêche-de-mer, dugong, and other fisheries are also of some importance.

Agriculture.— The soil and climate are suited for the production of all the ordinary cereals, as well as maize, tobacco, coffee, sugar, cotton, and other plants. Maize is more generally cultivated than any other cereal crop. The next crop in point of importance is sugar. All kinds of semi-tropical and English fruits are abundantly grown. Sheep-farming is the chief industry, and cattle-breeding is also important.

Commerce, Manufactures, Communications.— The principal imports are apparel and haberdashery, cottons and woolens, flour, iron and steel, boots and shoes, tea, spirits, hardware, machinery, wine, etc.; and the principal exports, wool, gold, tin, sugar, preserved meat, cotton, wood, hides, and skins. The imports come mainly from the United Kingdom and the United States. The value of the total imports in 1901 was about $31,880,000, of the exports $46,245,000. A duty of 5 per cent is charged on imports of yarns, woven fabrics, paper, stationery, etc.; and duties at other and even higher rates on other articles.

The manufactures are comparatively unimportant; the chief industrial establishments are sugar-mills, steam saw-mills, soap-works, distilleries, breweries, carriage-works, butter-factories, boot and shoe factories, cordial-factories, etc. There are over 2,800 miles of state-owned railway open. The most important lines are the three which reach the coast at Brisbane, Rockhampton, and Halifax Bay. There are also over 10,240 miles of telegraph lines, and an extending system of telephonic communication; 684 vessels with an aggregate of 853,515 tons entered, and 675 vessels of 832,305 tons cleared the ports of the state in 1901.

Government, Education, and Religion.— The government is vested in a governor, who is the king's representative, an executive council, and a parliament of two houses, the legislative council and the legislative assembly. The council consists of 39 members appointed by the crown for life, and the assembly of 72 members elected by the people for three years, and representing 61 electoral districts. The revenue of the colony exceeds $20,000,000, and the expenditure is usually less; the debt is about $170,000,000. Education is free and secular in the state schools. A university is to be established for the state. There is no state church, each religious denomination being entirely self-supporting. Anglicans predominate, with Roman Catholics second.

History.— The first settlement of Queensland took place in 1825, when the territory was used as a place of transportation for convicts, who continued to be sent there till 1839. In 1842 the country was opened to free settlers. It was originally a part of New South Wales, until in December 1859, it was organized as a separate colony under its present name instead of the earlier one of Moreton Bay District. In 1901 it became one of the states of the Australian Commonwealth. Pop. (1891) 393,718; (1901) 503,266. See AUSTRALIA.

Consult: Russell, 'The Genesis of Queensland' (1888); Rutledge, 'Guide to Queensland' (1889); Weedon, 'Queensland Past and Present' (1897).

Queens'town, Ireland, a seaport town and important naval station, in the county and nine miles southwest of Cork, on Great Island, which is situated in Cork harbor, and rises abruptly to a considerable elevation. The streets rise above one another, and present a picturesque appearance. It has a splendid Roman Catholic cathedral. Queenstown is almost solely dependent on its military and naval establishments. It is an important port of call for mail steamers and was formerly known as COVE OF CORK. In honor of Queen Victoria's visit in 1849 the name was changed to Queenstown. Pop. about 8,000.

Queenstown, Ontario, Canada, village and picturesque summer resort of Niagara County, on the Niagara River, near the mouth of the gorge, seven miles below the falls, and opposite Lewiston, N. Y. Pop. 400. The Brock monument, 185 feet high, on the heights overlooking the village, commands a magnificent prospect, and commemorates the battle of 12 Oct. 1812, when Gen. Van Rensselaer commanding 6,000 United States troops near Lewiston, sent about 1,000 men across the river in the night to attack Queenstown preparatory to a further invasion of Canada. General Brock, the capturer of Detroit, commanded the British forces, but was killed early in the action. The rest of the American troops refused to cross the river, and the attacking party, overpowered by numbers, was compelled to surrender. The American loss in killed and wounded was 190, in prisoners 900; the British lost about 130 killed, wounded and prisoners.

Queiroz, kā-ē-rōs', **José Maria Eça de.** See EÇA DE QUEIROZ.

Quelpart, kwĕl'pärt, **Quelpaert,** or **Tamra,** an island off the southern coast of Korea, about 62 miles from the mainland. Tamra is the native name of the island. In form it is nearly oval; area, about 750 square miles. It is mountainous, the highest point, Mount Auckland, or Han-ra-san, is 6,650 feet in height. This mountain is an extinct volcano; three well defined craters exist, in each of which is a lake of pure water. One of the traditions held sacred by many of the natives, is that from these lakes came the first three men of the world. The principal town is Chyei Chyu. The chief industries are fishing, agriculture, cattle-raising, and manufacturing fine split-bamboo hats. Pop. 81,000. Consult: Hamel, 'Narrative of Captivity in Korea,' in 'Korea Without and Within' by Griffis; Belcher, 'Narrative of H.M.S. Samarang,' containing an account of the survey and mapping of the island, by the officers of the British ship Samarang.

Quenstedt, kwĕn'stĕt, **Friedrich August,** German mineralogist and geologist: b. Eisleben, Germany, 9 July 1809; d. Tübingen, Germany, 21 Dec. 1899. He was educated at Berlin and in 1837 became professor of geology and mineralogy at Tübingen where he remained until his death. He made valuable investigations in geology and mineralogy and in the latter science was first to apply the analytic method to the study of crystalline systems. He wrote: 'Methode der Kristallographie' (1840); 'Grundriss der bestimmenden und rechnenden Kristallographie' (1873); etc.

Quentel, kvĕn'tĕl, **Heinrich**, German printer: b. Strasburg; d. 1501. He established a press near the cathedral at Cologne and though the earliest dated work from his press is ‘Fratris Astexani Opus de Casibus Conscientiæ’ (1479) yet the earliest Low German version of the Bible, usually stated 1470, is undoubtedly from his types and probably from his press. The business was conducted in his name for some time after his death.

Quentin Durward, kwĕn'tĭn dėr'ward, a romance by Sir Walter Scott published in 1823. The scene of this tale is France during the reign of Louis XI.; the hero, Quentin Durward, is a Scottish archer, who, having a relative in the Scottish Guards of the French king, goes to France to seek his fortune. The book was written at the flood-tide of Scott's popularity at home; the ebb began with ‘St. Ronan's Well,’ published six months later.

Quérard, kā-rär, **Joseph Marie**, French bibliographer: b. Rennes 25 Dec. 1791; d. Paris 3 Dec. 1865. From 1819 to 1824 he was attached to a well known Vienna book firm and while there prepared the first part of his ‘La France Littéraire’, in which he gives a complete bibliography of France for the 18th and the beginning of the 19th centuries, including not merely notices of French writers, but of foreign authors whose works had been reprinted or translated in France. The whole work appeared in ten volumes (1827–42). Among other works of his are: ‘La Littérature Française Contemporaine,’ of which Quérard himself prepared only the first two volumes (1839–44); ‘Supercheries Littéraires Dévoilées’ (1845–56).

Quercia, kwār'chā, **Jacopo Della**, Italian sculptor: b. Quercia, near Siena, about 1371; d. 1438. He was the first Tuscan sculptor who combined observation of nature with study of the antique and thus reformed plastic art in Italy. His chief works are the sepulchral monument of Ilaria de Caretto in the cathedral at Lucca; a fountain adorned with the Madonna and emblematic figures of the virtues, Faith, Hope, Charity, Prudence, Justice, Temperance and Fortitude, at Siena; a marble font in the cathedral of the same city and the reliefs in the portal of the church of San Petronio at Bologna. Consult: Cornelius, ‘Jacopo della Quercia’ (1896).

Quer'citron, the internal part of the bark, used as a yellow dyestuff, of the black oak (*Quercus tinctoria* or *Q. velutina*), one of the finest of North American oaks (q.v.). The dye is due to a peculiar chemical principal, quercitrin, and is obtained by using alum or stannic chloride as a mordant. A finer yellow is said to be obtained when the decoction of the bark is previously boiled with dilute hydrochloric acid. In the United States it is used for tanning.

Quer'cus, the generic name for oak (q.v.).

Queres (*K'eres*, the aboriginal stock name), a group of Pueblo Indian tribes, numbering 3,582 individuals, in seven permanent villages on the Rio Grande and to the westward thereof, in New Mexico. They form the Queres, or Keresan, linguistic family, speaking a distinct stock language. The Indians claim to have had their origin at Shipapu, a mythic place in the north, from which they gradually drifted southward and occupied, still in prehistoric times, the Rito de los Frijoles, west of the Rio Grande, where they excavated the cavate lodges in the soft volcanic tufa cliffs still to be seen. These were abandoned before the coming of Coronado, in 1540, who found them in seven pueblos (excluding Acoma and probably Sia) forming the province of «Quirix,» along the Rio Grande. In 1630 they were reported by Fray Alonzo de Benavides to number 4,000, but this and other early estimates did not include Acoma. (See Pueblo.) The present Queres pueblos are as follows;

Cochiti (native *Kot'yiti*).— On the west bank of the Rio Grande, 27 miles southwest of Santa Fé. In prehistoric times the natives of Cochiti and San Felipe formed one tribe, but on account of the hostility of the Tewas (see Tanoan Indians), they divided, the latter building a village near their present pueblo, the former settling in the Potrero Viejo, which they later abandoned, moving to near their present location, where they were found by Oñate in 1598. The Cochiti villagers were active participants in the Pueblo revolt of 1680, killing their missionary, but continuing to occupy their town. On learning of the approach of the Spaniards to reconquer their town a couple of years later, they fled, with the people of Santo Domingo and San Felipe, to the Potrero Viejo, where they remained almost uninterruptedly until 1692, when they were induced by Vargas to return to their homes. The Cochiti and Santo Domingo people again fled to the Potrero, however, where they were assaulted by Vargas in 1693 and severely defeated, 200 of their women being captured and their pueblo burned. Cochiti became the seat of the mission of San Buenaventura early in the 17th century. Of the 16 clans 4 are extinct. Pop. 300.

San Felipe (native name *Katishtya*).— On the west bank of the Rio Grande, 12 miles above Bernalillo. Formerly combined with the people of Cochiti, but independently occupying the vicinity of the present site at least since 1540. It was the seat of one of the earliest missions of New Mexico, its first church being erected prior to 1607. The inhabitants participated with those of Cochiti and Santo Domingo in the great revolt of 1680, but aided Vargas in dislodging the Cochiteños from the Potrero Viejo in 1693. They had no resident missionary at the time of the revolt, but aided in murdering the priests of Cochiti and Santo Domingo. After leaving the Potrero in 1692 the San Felipe people built a new pueblo on a mesa northwest of their present town, where a church (the walls of which are still standing) was erected in 1694. This was abandoned early in the 18th century and the present pueblo established, the fourth to bear the name Katishtya. Of the 30 San Felipe clans 9 are extinct. Pop. 550.

Santo Domingo (native name *Kiwa* or *Dyiwa*).— On the east bank of the Rio Grande, 18 miles above Bernalillo. In prehistoric times the inhabitants occupied successively the Potrero de la Cañada Quemada and two pueblos called Guipuy, in the latter of which, on the Rio Grande, they were found by Oñate in 1598. Like its predecessor, the second Guipuy, as well as Huashpatzena, the settlement which followed, was swept away by flood, and the present Santo

Domingo has had three similar but less severe disasters between its founding in 1692 and 1886, when a freshet destroyed its fine old church with carved doors bearing the Spanish coat of arms. At the time of the Pueblo rebellion of 1680, it was an important mission seat and the residence of the custodian of the province, who, with two other priests, were slain. The pueblo has 18 surviving clans and a population of 670.

Santa Ana (native name *Tamaya*).— On the northern bank of the Rio Jemez, a western tributary of the Rio Grande. Before the Spanish advent the inhabitants lived nearer the Rio Grande and in 1598 resided on a mesa between the present pueblo and San Felipe. They joined the San Felipe and Santo Domingo people in the great revolt, but in 1687 their village was carried by storm and burned, several of the natives perishing. The present town was built after 1692. It became a mission early in the 17th century, but had no resident missionary at the time of the rebellion. Santa Ana has 7 clans and a population of 228.

Sia (native *Tsia*).— On the north bank of Jemez River, 16 miles northwest of Bernalillo. It was formerly a pueblo of great importance, and in 1583 was said by Espejo to be the chief one of five towns forming the province of «Punames.» It early became the seat of Nuestra Señora de la Asuncion. Its inhabitants made a most determined stand during the revolt of 1680, but in 1689 they were assaulted by the Spaniards, their pueblo wrecked, and the tribe decimated in the bloodiest engagement of the rebellion. Since this time the little tribe has been declining, its present population being about 125. Sia formerly had 37 clans, but of these only 16 survive.

Acoma (from *Akóme*, «People of the White Rock»).— This pueblo and Laguna from the western division of the Queres stock. Acoma is picturesquely and strongly situated on a rock mesa, 357 feet high, about 60 miles west of the Rio Grande. It was first mentioned as «Acus» by Marcos de Niza in 1539 and visited by Coronado in 1540. Acoma has the distinction of being the oldest continuously occupied town in the United States. The natives treacherously killed several Spaniards of Oñate's force late in 1598, but in the following January the Spaniards led an expedition against the mesa, stormed and captured the town, killed about half the inhabitants, and burned some of the houses. Acoma became the seat of the mission of San Estevan in 1629; the natives murdered their missionary in the revolt of 1680, and remained in their fortified retreat until 1699, when they were induced to submit to the Spanish authorities. The present large adobe church, with its remarkable cemetery filled in with earth carried from the valley below, dates from the reconquest. In prehistoric times the Acomas lived on the summit of an even loftier mesa, known as Katzima, or the «Enchanted Mesa,» three miles northeastward. According to tradition (verified by an examination of the summit and the surroundings of the mesa by F. W. Hodge in 1897), the only trail was washed away in a storm, leaving some of the inhabitants to perish; the village was henceforth abandoned. Population in 1680, 1,500; in 1760, 1,052; in 1902, 566. Of the 20 original clans 6 are now extinct.

Laguna (Span. «lagoon,» from a lake formerly west of the pueblo; native name *Kawaik*).— The largest of the Queres towns, and the most recently established of all the southwestern pueblos, having been founded in 1697 by refugee Queres from other villages, particularly Acoma, as well as by Indians of other stocks. It is situated on the Santa Fé Pacific railroad, 17 miles northeast of Acoma. The town is being gradually abandoned, many of its inhabitants having moved permanently to their eight farming villages to the north and west. The Lagunas are very intelligent, honest and industrious, and are largely in demand as railroad laborers. The mission name of Laguna is San José, applied also to the rivulet on which the town is situated. The tribe has 20 clans. Population 1,143.

F. W. Hodge,
Smithsonian Institution, Washington, D. C.

Queretaro, kā-rā'tā-rō, Mexico, a state bounded on the north by San Luis Potosi, on the east by Hidalgo and Mexico, on the south by Mexico and Michoacán, and on the west by Guanajuato. Area, 3,556 square miles. See Mexico — the States of.

Queretaro, Mexico, capital of the State of Queretaro, distant from the City of Mexico by the National Railway 167 miles and by the Central 153 miles, and from El Paso, Texas, by the Central 1071 miles and from Laredo, Texas, by the National 580 miles; elevation 5,904 feet above sea level. Here is the famous Hercules Cotton Mill, one of the oldest and most extensive in the Republic, employing almost 2,000 operatives, and here are also several other manufacturing industries, including woolen mills. Some miles distant are the famous opal mines, which have been worked for centuries, producing enormous quantities of the precious stones, but which are now becoming gradually exhausted. The water supply is obtained from the mountains through a great stone aqueduct five miles in length. The city has a complete system of electric lighting, a well equipped street railway and many substantial business structures. The Bank of Queretaro, with a capital of $1,000,000, a branch of the National Bank and an agency of the Bank of San Luis Potosi supply the financial needs of the community. There are numerous churches, one of the oldest and most prominent of which is the Santa Rosa. The Civil College is the most notable educational institution. In this are taught law, engineering, chemistry, etc. There are two museums, one of which is devoted to history and the other to commerce; and a library connected with the Civil College contains 9,000 volumes. Other notable buildings are the Government Palace, built of bosalt, the Iturbide Theatre and a bull-ring; there are also numerous parks. The city was founded by the Aztecs about 1440; was conquered by the Spaniards in 1531 and is noted in modern history as the scene of the capture, imprisonment and execution of Emperor Maxmillian in 1867 by the Mexican government. Pop. about 38,000.

Quern, a mill, especially a hand mill for grinding corn, used before the invention of water or windmills. It consisted of two circular stones, the lower of which was slightly dished, and the upper one was pierced in the centre, and revolved on a wooden or metal pin inserted in the lower. The grain was dropped with one hand into the central opening, while with the other the upper stone was revolved by means of a stick inserted in a small opening or hole near the edge.

Quesada, kā-sä'thā, **Gonzalo de,** Cuban diplomatist: b. Havana, Cuba, 15 Dec. 1868. He was graduated from the College of the City of New York in 1888 and afterward studied at Columbia. He was secretary of the Cuban revolutionary party and associated with José Marti in the endeavor to effect Cuban independence. He served as special commissioner of Cuba to the United States in 1900, was Cuban commissioner to the Paris Exposition, and in 1901 became a member of the Cuban Constitutional Convention. He has published ‹Patriotism›; ‹History of Free Cuba.›

Quesada, Gonzalo Ximenes de. See XIMENES DE QUESADA.

Quesaltenango, kā-säl-tā-nän'gō. See QUEZALTENANGO.

Quesnay, kā-nā, **François,** French economist; b. Mérey, near Versailles, 4 June 1694; d. Versailles 16 Dec. 1774. He was at first a surgeon, and in 1737 was made perpetual secretary of the surgeons' academy; but in 1744 he received a physician's certificate and became a favorite physician at the court of Louis XV. His works on professional subjects are wholly antiquated and he is best known as the chief of those economists whom Dupont de Nemours called the «physiocrats.» The principal tenets of this school were that there exists a natural order, with which human government should interfere as slightly as may be, and that all wealth is derived from the soil. Extravagant praise was heaped on Quesnay, who was called the «European Confucius,» while his ‹Tableau Economique› (1758) was styled by Laharpe «the Koran of economists.» His economical works appeared in 1768. Consult Higgs, ‹The Physiocrats› (1897).

Quesnay de Beaurepaire, dė bō-rē-pār, **Jules,** French jurist and author, known also by the pseudonym JEAN GLOUVET: b. Saumur 2 July 1838. He studied law, became for a time a journalist, later entered definitely upon a legal career, and in 1889 was made procurator-general of the Paris court of cassation. In that capacity he appeared for the government before the Senate, constituted as a high-court of justice with charges against Boulanger (q.v.) and the latter's accomplices, Dillon and Rochefort. In 1892 he was appointed president of the chamber of the court of cassation, from which post he was compelled in January 1899 to retire, owing to the fact that his aggressive attitude in the Dreyfus revision was interpreted by his colleagues as an evidence of bias. Among his works are: ‹Le Forestier› (1880); ‹Histoires du Vieux Temps› (1883); ‹L'Etude Chandoux› (1885); ‹France, 1418–29› (1895); and ‹Le Panama et la République› (1899).

Quesnel, Pasquier, pās-kē-ā kā-nĕl (PASCHASIUS), Roman Catholic theologian: b. Paris 14 July 1634; d. Amsterdam 2 Dec. 1719. In 1657 he entered the order of Oratorians, but subsequently through his publication of the ‹Works of Leo the Great› (1675) with annotations, in which he maintained the independence of the Gallican Church, he incurred the displeasure of the Holy See, and as he refused in 1687 to subscribe to an anti-Jansenist declaration, he was obliged to take refuge in Brussels with Arnauld (q.v.) where he employed himself in completing his edition of the New Testament with moral reflections. The Jesuits, thereupon, obtained from Philip V. of Spain, a writ through which Quesnel was taken in custody as guilty of Jansenism (1703). With the aid of his brother, however, he escaped and fled to Amsterdam, where he lived to see 101 passages in his New Testament condemned by the Holy See in the bull ‹Unigenitus.›

Quetelet, kĕt-lā, **Lambert Adolphe Jacques,** Belgian statistician and astronomer: b. Ghent 22 Feb. 1796; d. Brussels 17 Feb. 1874. In 1814, he became professor of mathematics at Ghent, in 1819 was appointed to the same chair in the Brussels Athenæum and was lecturer in the Museum of Science and Literature 1828–34. Quetelet superintended the erection of the Royal Observatory and was its first director from 1828 till his death. His writings on statistics and kindred subjects are very numerous, and among them may be named: ‹Sur l'Homme et le Développement de ses Facultés, ou Essai de Physique Sociale› (1835); ‹Sur la Théorie de Probabilités appliquée aux Sciences Morales et Politiques› (1846); ‹Sur le Système Social et les Lois qui le régissent› (1848); ‹Histoire des Sciences Mathématiques et Physiques chez les Belges› (1864); and ‹L'Anthropométrie› (1871). He applied the mathematical methods of averages and probabilities to the study of man both as an individual and as a member of society.

Quetta, kwĕt'ta, British Baluchistan; city, on a railroad which belongs to the India railway system; and about 100 miles north of Khelat. It is a commercial and industrial centre for a large region; but it is of great strategic importance, on account of its position among high mountains and that it commands both Bolan and Khojok passes. It is strongly fortified, and has an arsenal and a garrison. It has become a flourishing place since 1876, when a British residency was established here. Pop. about 25,000.

Quet'zal. See TROGON.

Quetzalcoatl, a god of the Nahuas, primitive inhabitants of Mexico. The name Nahuas is applied to those tribes, apparently of the same origin, which successively ruled in Anahuac, or the Mexican Empire. All Nahuatl legends agree on the arrival in that region of certain bearded white strangers, garbed in black, who came to proclaim new doctrines to the Nahuas. These strangers have by some been without justification identified as Buddhist missionaries. The only definite information regarding them relates to their chief, who was called Quetzalcoatl, a name signifying, perhaps, «the serpent covered with feathers,» though other meanings have been assigned. The earlier Spanish authors viewed Quetzalcoatl as St. Thomas, who had come, they thought, from India. The legendary material connected with him is extensive, varied, and confusing. He was worshipped as the incarnation of Tonacateatl, the serpent sun, and supreme deity in the Nahuatl mythology. Many temples were built to him. Excavations everywhere unearth his image, in various guises in both stone and terra-cotta. His attributes were expressed in many bas-reliefs. American and European museums contain representations of him. A full account may be found in Bancroft (H. H.), 'Native Races of the Pacific States' (1875).

Queue Rouge, kē roozh, a West Indian name for a large spider much dreaded by the negros. See LATRODECTUS.

Quevedo y Villegas, kā-vā'thō ē vēl-yā'gäs, **Don Francisco de,** Spanish author: b. Madrid 26 Sept. 1580; d. Villanueva de los Infantes 8 Sept. 1645. After study at the University of Alcalá, he was banished the country for having killed a nobleman in a duel, and went to Sicily, where he entered the service of the viceroy, the Duke of Osuna, by whom he was later made minister of finance in the administration of Naples. After his return to Spain he was arrested in 1639 on suspicion of having written some satiric verses against the king and ministry, and subjected to a four years' imprisonment, the rigors of which caused his death. He is best known for his prose satires, such as 'History of the Great Sharper, Paul of Segovia' (1627), and 'Visions' (1635). The latter were rendered into English by Sir Roger L'Estrange in 1708. There is a Spanish edition of his works by Guerra y Orbe (1852). Consult the study by Mérimée (1886).

Quezaltenango, kā-säl-tā-nän'gō, or **Quesaltenango,** Guatemala, city, capital of a department of the same name, the second city of the Republic in size and in importance, 80 miles west of Guatemala city, at an altitude of 7,500 feet above sea-level. The town is well-built with wide and well-paved streets; among its handsome public buildings are the cathedral, city hall, and penitentiary. It has a considerable domestic trade, and manufactures of cotton and woolen textiles. A railway about 50 miles long connects Quezaltenango with Champerico on the Pacific coast. The city was founded in 1524 by Spaniards, on the site of a native city; there are numerous interesting antiquities in the neighborhood.

Quiañgan, kē-äng-än', Philippines, a former Spanish commandancia, bounded on the north by Bontoc, now a part of the province of Lepanto; area 64 square miles; pop. 30,000. See LEPANTO.

Quianganes, kē-äng-än'äs, a tribe of the Philippines, living in the commandancia of Quiañgan, province of Lepanto, Luzon. They belong to the Ifugas linguistic stock, and are a headhunting people.

Quibdo, kēb'dō, Colombia, town in the department of Cauca, formerly the capital of the ancient province of Choco; on the Atrato River; about 30 miles from the Pacific and 200 miles northwest of Bogota. It was of considerable commercial importance when the gold mines of the vicinity were being worked; but the majority of the mines are now abandoned owing to lack of use of modern methods of mining. The surface gold exists now only in small quantities. Pop. about 7,500.

Quiberon, kē-brôn, France, town, in the department of Morbihan; on the Bay of Quiberon, on a peninsula, about 22 miles southwest of Vannes. Nearby and on the peninsula are the noted megalithic monuments of Carnac (q.v.). Quiberon is now only a small fishing town; but it is of historical interest on account of the unsuccessful attempt of an English force to land here, in 1746, at the time of the Seven Years' war. On 20 Nov. 1759 Admiral Hawke attacked and overcame a French fleet under Admiral Conflans in Quiberon Bay, near the town. On 27 June 1795 a body of about 1,400 of French emigrant royalists landed here from an English fleet, and tried to arouse the people of La Vendée and Brittany against the Convention. They were repulsed by a force under General Hoche, some returned to their ships, and those who were taken prisoners were shot.

Quiché, kē-chā', or **Kiché,** an ancient nation of western Guatemala, the people of which were civilized and of the Mayan stock. Their language was a dialect allied to that spoken by the Cakchiquel. Their extant chronicles begin with the 8th century. In their sacred book, Popol Vuh, an account is given of the life of their great culture hero Xbalanque. This book gives many of the national traditions, written in the Quiché dialect. The first part of the book contains mythological accounts of their history, people, events, etc.; the second part is a detailed history of the origin of the tribe and some account of the Cackchiquel. The descendants of the Quiché now inhabit a large region in the central and western part of Guatemala. Consult: Ximenez, Spanish translation of Popol Vuh (Vienna, 1857); Abbé Brasseur de Bourbourg, French translation of Popol Vuh (Paris, 1861).

Quichua, kē-choo'ä, **Quechua,** or **Kechua,** the tribe who founded the Indian empire of Peru. The tradition as to the origin of this aboriginal empire is that it was founded by Manco Capac, the fourth son of the "creator god," Viracocha (q.v.). Much of the legendary and traditional history has been relegated to the domain of mythology by modern research, but the mythical tale was founded on some fact in nature or history. The descendants of this tribe, a large part of the population of the Peru of to-day, are still looked upon as being a superior people. In 1781 one of the tribe proclaimed himself as the reincarnation of the great Inca Tupac Amaru, gathered about him a number of zealous followers, led a revolt against the Spanish power, which was suppressed only after two years, and upon the capture of the leader, his family, and his leading followers. See PERU.

Quichuan (kē-choo'an) **Stock,** a South American Indian group composed of numerous tribes, chief of which are the Quichua (q.v.), inhabiting Peru, parts of Ecuador, Bolivia, etc. With the Aymaras the Quichuas composed the larger portion of the population of the empire of the Incas. The Quichua language, which was formerly the state language of the Incas, is still the chief speech of Peru, of a large portion of Bolivia, of the part of Ecuador bordering upon Peru, and of the northern section of the Argentine Republic. It is one of the most beautiful and at the same time comprehensive tongues of America.

Quick-firing Guns. See ORDNANCE.

Quick-sand, a tract of loose sand mixed with water which will not support heavy bodies.

In appearance quick-sands do not differ from the adjacent sands. They usually occur on flat shores underlain by stiff clay or other impervious materials and especially near the mouths of large rivers. They appear to be formed by the continued collection of water within the sand bank which is prevented from running off by the underlying impervious layer. The water which infiltrates the sand may be supplied, either by a river current, directed against a concave shore, or spreading over a sea-beach; by tides which at their ebb leave behind them imprisoned bodies of water; or by sea-currents running through narrow channels and forcing the water against the adjacent shore. The grains of quick-sand have rounded surfaces, as distinguished from angular or «sharp» sand. It is, moreover, of very light weight. The infiltrated water separates and lubricates the particles, rendering them unstable and unable to support a heavy weight, such as the body of a man. They have obtained a great reputation for treachery and danger, especially because they cannot be distinguished at sight. The subject has been drawn upon considerably in literature, notably in Hugo's 'Toilers of the Sea,' in Wilkie Collins' 'Moonstone' and in the 'Bride of Lammermoor,' with probably some exaggeration of the danger. The effect of quick-sands, however, is well illustrated by the sinking in 1875 of a locomotive and train at Pueblo, Colo., which sank beyond discovery though probed for to a depth of 50 feet. To make it possible to operate in quick-sands engineers are accustomed to congeal them by forcing into them brines and liquids at low temperatures.

Quicksilver. See MERCURY OR QUICKSILVER.

Quids, in American political history, a name applied to a faction of the Republican party led by John Randolph from 1805 to 1811. They were opposed to the nomination of Madison, Jefferson's choice for the succession. They declared war on the administration party in 1806, as governing Congress by backstairs influence. They opposed the restrictive system, and nominated Monroe in 1808. Their leading ground of divergence from the administration was that it had moved away from the ground occupied by the party when in opposition, and in the direction of centralization and federal encroachment.

Quietism, a tendency in religious devotion rather than any specific system of religion or mysticism. It consists in making Christian perfection a state of uninterrupted contemplation of divine things, the soul meanwhile remaining quiet and entirely passive under the divine influence, heedless of the customary precepts of practical religion, and without thought of rewards or punishments in another world, which are the master motives of vulgar piety. The term Quietism was first used to designate the mystical teaching of Miguel de Molinos (q.v.) who died (1696) in the prison of the Holy Office at Rome to which he had been condemned for teaching in sundry of his writings that the perfect Christian life consists in passive contemplation, unaffected by hopes or desires, and that the soul thus occupied neither gains by good works or acts of piety, nor suffers through the commission even of gross sins, for these affect only the lower nature of the devotee and cannot bring any stain upon the purity of a contemplative soul. The amiable Fénelon (q.v.) was won over to hearty acceptance of some of the less objectionable features of Quietism by the influence of his disciple Madame Guyon (q.v.), several of whose mystical writings he approved and defended when they were condemned by the Gallican church authorities, among them Bossuet, bishop of Meaux, who declared them to be a «mass of extravagances, illusions, and puerilities.» Fénelon's published apology for the doctrines of Madame Guyon having been censured at Rome as containing propositions rash, scandalous, etc., he promptly bowed to the judgment of the Holy See, publicly committing his own book to the flames.

Quietists. See RELIGIOUS SECTS; QUIETISM.

Quigley, James Edward, American Roman Catholic prelate: b. Oshawa, Ontario, Canada, 15 Oct. 1854. He was graduated from Saint Joseph's College, Buffalo, N. Y., in 1872. He then began his theological studies at the Vicentian Seminary, Niagara, N. Y., now Niagara University, and continued them at the University of Innsbruck, Austria, completing his entire course at the Propaganda, Rome, where, in 1879, he obtained the degree of doctor of theology, and was ordained priest 13 April of the same year. Returning to the United States, he was appointed pastor of the Church at Attica, Wyoming County, N. Y., and in 1884 was named rector of the Cathedral, Buffalo, N. Y. In 1896 he asked to be transferred to the rectorship of Saint Bridget's Church, Buffalo, made vacant by the death of Mgr. Gleason, but his residence in that parish was short, as, on 24 Feb. 1897, he was consecrated bishop of Buffalo to succeed Bishop Ryan, deceased. Bishop Quigley was chosen arbitrator in the great labor strike in Buffalo during 1904, and on 8 Jan. 1903 was promoted to the archiepiscopal see of Chicago. The archdiocese comprises a Catholic population of approximately 1,000,000; 619 priests; 316 churches; 168 parochial schools; 7 orphan asylums; 18 hospitals, and many other charitable and educational institutions.

Quill, the hollow stem of a feather (see PLUMAGE). Many utilities have been found for those of the larger size, but their use is declining. The principal use of quills is still for making pens, for which the feathers of the swan are most highly esteemed, but goose-quills are most commonly used. Crow-quills are said to be best for fine writing and drawing. In preparing quills for making into pens, they must first be cleaned inside and outside of fatty matter, which would prevent the ink from flowing freely. This is done by burying the quill-ends of the feathers for a few seconds in fine sand at a temperature of about 140° F. The quills are then polished and dried.

Quillaia (kwĭl-lā'yä) **Bark,** the bark of a South American tree (*Quillaja saponaria*), belonging to the division *Spiræa* of the order *Rosaceæ*. The tree has smooth, oval leaves, and white terminal flowers, solitary or in small clusters.

Quiller-Couch, kwĭl'ĕr kowch, **Arthur Thomas,** English author: b. Cornwall 21 Nov. 1863. He was educated at Oxford, where he was classical lecturer in 1886–7, and won some success with his first book, 'Dead Man's Rock' (1887). In 1887 he began a literary career in

London, where in 1889 he joined the staff of the 'Speaker,' the Liberal weekly newly established by Sir Wemyss Reid (q.v.). He retained until 1899 his connection with the 'Speaker,' a part of his contributions to which appear in the collections of short stories, 'Noughts and Crosses' (1891) and 'The Delectable Duchy' (1893). Among his further volumes are: 'Green Bays: Verses and Parodies' (1893); 'The Golden Pomp' (1895), an Elizabethan anthology; 'Ia' (1896); 'Adventures in Criticism' (1896); being selected reviews; 'The Ship of Stars' (1899); 'Old Fires and Profitable Ghosts' (1900); 'The Laird's Luck' (1901); 'The Westcotes' (1902); 'The White Wolf' (1902); 'The Adventures of Harry Revel' (1903); 'Hatty Wesley' (1903); and 'Shining Ferry' (1904). He also completed 'St. Ives,' left unfinished by Robert Louis Stevenson (q.v.). Much of his earlier work appeared over the pseudonym 'Q.' Much of his material he has derived from Cornwall, where he has made particular study of the Welsh poor.

Quil'liam, William Henry Abdullah, English Mohammedan writer: b. Liverpool 10 April 1856. He was educated at King William College, Isle of Man, and was admitted a solicitor in 1878. He visited Morocco in 1884 and became a Mohammedan the following year. He made subsequent visits to Morocco, Turkey and Persia, and in 1895 the Ameer of Afghanistan awarded him the title of Sheik-ul-Islam of the British Isles. He has been special commissioner for Canadian oaths since 1884 and has published: 'The Faith of Islam' (1887); 'Fanatics and Fanaticism' (1888); 'Religion of the Sword' (1889); 'Polly,' a novel (1891); 'The Ways of Sin,' a novel (1894); 'Moses, Christ and Mohammed' (1897); 'Studies in Islam' (1898); 'Manx Antiquities' (1898).

Quilp, kwĭlp, a malicious and hideous dwarf who figures prominently in Charles Dickens' novel, 'Old Curiosity Shop.' He torments and abuses his wife Betsey, and when about to be arrested for felony drowns himself.

Quil'ter, Harry, English artist and author: b. Lower Norwood, Surrey, 24 Jan. 1851. He was educated at Cambridge, studied at Bruges and in Italy, and in 1878 was called to the bar. In 1876–88 he was connected with various London newspapers, and in 1888–90 he conducted the 'Universal Review' which he founded. His first exhibition of paintings in oil was made at the Royal Institute in 1884, and in 1894 his collected works, 120 in number were exhibited at the Dudley Gallery. He is the originator of 'What's What,' first issued in 1902, and has published: 'Giotto' (1880); 'Is Marriage a Failure' (1889); 'Preferences in Art, Life, and Literature' (1892); etc.

Quimper, kăn pār', France, sometimes called QUIMPER-CORENTIN, capital city of the department of Finistère, lying at the junction of the Steir and Odet, whence the name from Breton 'Kemper,' junction or confluence. It has the fine cathedral of St. Corentin, built in 1424. The old capital of Cornouailles, it figured in the religious wars. It has sardine-fisheries, breweries, paper-factories, tanneries, and a population of about 20,000.

Quin, kwĭn, **James,** English actor: b. London 24 Feb. 1693; d. Bath, Somerset, 21 Jan. 1766. He was the son of an Irish barrister, and was educated in Dublin. In 1714 he went upon the Dublin stage, and a year after appeared at Drury Lane Theatre. In 1717 he went to the theatre in Lincoln's-Inn-Fields, where he remained 14 years, and acquired celebrity in characters of grave, dignified, and sententious tragedy, as in Cato, Zanga, and Coriolanus (in Thomson's tragedy of that name), and in those of strong, sarcastic, comic humor, as Falstaff and Volpone. In 1735 he returned to Drury Lane, on such terms as no actor had previously received; and he retained preeminence until the appearance of Garrick in 1741. In 1747 he was engaged at Covent Garden with Garrick; but the new actor obtained so great a share of attention that Quin retired from the regular stage in 1751. His last performance was Falstaff (1753), in which character he is supposed never to have been excelled. Garrick, once his rival and afterward his friend, wrote the epitaph for his monument in Bath Abbey.

Quinault, kē-nō, **Philippe,** French dramatist: b. Paris 3 June 1635; d. there 26 Nov. 1688. He studied law, but became a playwright, his first drama being produced when he was 18 and meeting with marked success. The continued success of his tragedies, comedies, and tragicomedies, of which he produced 16, made him a mark for the satire of Boileau, and he abandoned tragedy and engaged in writing librettos for the operas of Lulli. In this field he displayed great originality and though his success at the time was attributed to Lulli's music by Boileau and other critics, his verse is still read and admired while the music is forgotten. He was admitted to the French Academy in 1670 and his later years were spent in ease and comfort. Of his operatic pieces 'Armide' and 'Atys' are best known and of his dramas 'Astarte' (1663) and 'La Mère Coquette' (1665). Editions of his works were published in 1739, 1842, and 1880.

Quince, a shrub or small tree (*Cydonia vulgaris*) of the rose family; a native of central and eastern Asia, where it was cultivated more than 2,000 years ago and whence it has been introduced into all cool temperate countries of the civilized world. It is a close relative of the apple and pear, with which trees some botanists class it, but from which it is distinguished by having its flowers solitary upon the ends of twigs of the present season's growth. The popularity of the quince is limited because it is inedible in the fresh state, but it is highly prized for making preserves, jellies, etc., and as a flavoring for mixing with other fruits.

The plant is propagated mainly by stool layering, the rooted layers being grown in nursery rows usually two years after their removal from the parent bush. They are then planted from 10 to 15 or more feet apart, the distance depending upon the soil. On light soils the shrubs make rapid growth but are shorter lived and less productive than upon heavy. They should commence to bear when about three years old and reach full bearing when ten. Contrary to popular opinion the quince will do best when cultivated, but the stirring of the soil must not be deep because the feeding roots are rather close to the surface, especially if the soil be very moist. To obviate this danger, growers often set the plants rather deeply and for the first few years work the soil away from them so as to induce deep rooting. They always use shallow rooting cover crops. It is another popular misconception that the plants do best in undrained soil. The best orchards of western New York, where the quince is an important crop, are upon well drained land.

The tree seldom grows more than 15 feet tall. It should be trained in bush form; that is, with several stems, though some growers prefer the tree form with only one stem. The latter seems more likely to be injured by borers. Beyond the removal of interfering, dead or unnecessary limbs the pruning consists of «heading-in» the twigs, a process which reduces the number of fruits. Being fairly hardy and a rather late bloomer the quince is a very regular annual bearer, but unless the tops be kept open and the quantity of fruits reduced the specimens will be inferior. Though the fruits ripen late and when gathered are generally very hard they should be handled very carefully and not be allowed to freeze. Except as indicated the management of a quince orchard is much the same as for pear orchard.

Among the insects which feed upon the quince are several borers, scale insects, caterpillars, plant-lice, etc., which are found on other fruit trees, especially apples and pears. These may be controlled in the same way. (See APPLE; PEAR; INSECTICIDE.) The quince curculio (*Conotrachelus cratægi*), a broad-shouldered snout-beetle of American nativity, lays its eggs in the fruit in early summer. It may be controlled like its relative the plum curculio. (See PLUM.) Several so called plant diseases common to the pear and apple are sometimes reported upon the quince. They have been combated in the same way as on the other fruits.

Consult: Bailey, ‘Cyclopedia of American Horticulture’ (New York, 1900–2); Meech, ‘Quince Culture’ (New York, 1896).

Quin'cke, Georg Hermann, German physicist: b. Frankfort-on-the-Oder 1834. He was educated at the universities of Berlin, Königsberg, and Heidelberg, and in 1859 was privatdocent at the University of Berlin. In 1872 he was appointed to a chair at the University of Würzburg, and in 1875 became professor of physics at Heidelberg. He has made important investigations of capillary phenomena, and valuable researches respecting electric influence upon different forms of matter.

Quin'cunx, an arrangement of five objects in a square, one at each corner and one in the middle. It is particularly employed in reference to the arrangement of trees. The term is frequently used in astronomy.

Quincy, kăṅ-sē, **Antoine Chrysostome Quatremère de.** See QUATREMÈRE DE QUINCY, ANTOINE CHRYSOSTOME.

Quincy, kwĭn'zĭ, **Edmund,** American author, son of Josiah Quincy (1772–1864 q.v.); b. Boston, Mass., 1 Feb. 1808; d. Dedham, Mass., 17 May 1877. He was graduated from Harvard in 1827, was a prominent and able contributor to the anti-slavery press and wrote: ‘Wensley’ (1854); ‘Life of Josiah Quincy’ (1867); etc.

Quincy, Josiah, sometimes called JOSIAH QUINCY, JR., American lawyer: b. Boston, Mass., 23 Jan. 1744; d. at sea off Gloucester, Mass., 26 April 1775. He was graduated from Harvard in 1763, studied law in the office of Oxenbridge Thacher, and acquired a large practice. After the «Boston Massacre» (q.v.), he was selected with John Adams, by Captain Preston as counsel for the defense. He wrote many political pamphlets, and contributed much to contemporary journals. In 1774 he sailed for England, where he consulted with the friends of America, but died on the return voyage. An able orator, he was among the first to assume a bold revolutionary attitude. Though he incurred at the time some odium for his defense of Parker, his course was later strongly commended.

Quincy, Josiah, American statesman and educator: b. Boston 4 Feb. 1772; d. Quincy, Mass., 1 July 1864. He was graduated from Harvard in 1790, studied law and in 1793 was admitted to practice, and gave much study to political problems. By his oration in Old South 4 July 1798, he gained so extended a reputation that in 1800 he was made Federalist candidate for representative in Congress. Though defeated then through the ridicule of Republican journals, he was elected in the autumn of 1804 after having in the spring of that year been chosen to the State senate. He remained in Congress until 1812, when he declined re-election. He was a finished orator, spoke boldly on many difficult topics of debate, and was one of the most efficient members of his party, which during his whole term of service remained hopelessly in the minority. His statesman-like grasp of affairs is most clearly shown by the constant emphasis which he placed upon the increasing political danger with which the Union was menaced by the slave power. He feared civil war, and preferred a peaceable secession — a course not then seen, as it was later, to be impossible. In the State senate he urged Massachusetts to suggest to Congress an amendment of the Constitution, by which the clause permitting slave-States to reckon three fifths of the slave population in obtaining a basis for representation was to be stricken out. Of course, such a measure, had it succeeded, would have resulted in the dismemberment of the Union. Quincy opposed the annexation of the Louisiana territory, and in his speech of 4 Jan. 1811 took the advanced Federalist position that the Constitution did not confer on Congress power to admit any new States save such as might be formed from territory belonging to the United States in 1787. He declared that, if the bill passed, the Union was thereby dissolved, and that it would be the right of all States and the duty of some «to prepare definitely for a separation.» This is believed to be the earliest enunciation in Congress of the doctrine of secession. Eventually Quincy acquiesced in the purchase, upon each of the original 13 States signifying its assent. He attacked the Embargo, and opposed the War of 1812, though, unlike many Federalists, he supported the administration, and on 25 Jan. 1812 made in the House a notable speech on the navy. Upon his retirement from Congress in 1813, he was at once elected to the State Senate, where he remained until 1820, then entering the House of Representatives, of which he was speaker until his resignation in 1822 to become judge of the Boston municipal court. In this capacity he was the first to hand down the ruling, then much criticized but now accepted in the United States and England, that the publication of truth with good intent and for a justifiable end is not libel. From 1823 to 1828 he was second mayor of Boston; during his administration all the municipal departments were put in efficient working order. In 1829 he became president of Harvard, and this post he held until his retirement in 1845. In 1856 he was a supporter of Frémont for the Presidency. Besides several speeches, he published: 'History of Harvard University' (1840); 'History of the Boston Anthenæum' (1851); 'The Municipal History of Boston' (1852); 'Memoir of John Quincy Adams' (1858), and other works. Lowell refers to him as "a figure of admirable example in a democracy as that of a model citizen." Consult: Quincy, 'Memoir' (1867); Lowell, 'A Great Public Character' in 'My Study Windows' (1867).

Quincy, Josiah, American lawyer, son of Josiah Quincy (1772–1864, q.v.): b. Boston, Mass., 17 Jan. 1802; d. Quincy, Mass., 2 Nov. 1882. He was graduated from Harvard in 1821, served as president of the Massachusetts senate in 1842, was mayor of Boston in 1845–9 and wrote 'Figures of the Past' (1882).

Quincy, Josiah, American politician, son of Josiah Phillips Quincy: b. Quincy, Mass., 1859. He was graduated from Harvard in 1880, and was admitted to the bar but never practised. He has been a leading member of the Democratic party, was chairman of that party's State Committee, and manager of the literary bureau of the National Committee in 1892. He served four years in the Massachusetts legislature, and in 1893 was appointed assistant secretary of state by President Cleveland, serving six months. In 1895 he was elected mayor of Boston and in 1897 re-elected, his progressive policy in regard to the extension of municipal functions attracting wide attention. He established the department of municipal statistics, a municipal printing-office and electrical construction department, greatly increased the number of public baths, and provided public lectures and concerts, and organized eight unpaid commissions to have charge of the city's charitable institutions, public baths and other improvements.

Quincy, Ill., the capital city of Adams County, is situated on the east bank of the Mississippi River, 264 miles south of Chicago and 160 miles north of St. Louis. It was, according to the census of 1900, the third city in the State of Illinois. It is built upon an elevated plateau 160 feet above the high-water mark of the Mississippi River. The water supply of Quincy is given from a reservoir with a capacity of 20,000,000 gallons at an elevation of 229 feet above the city, giving an average pressure of 40 pounds, the water before entering the reservoir being thoroughly filtered, making it absolutely pure. In consequence thereof the death rate has been materially decreased, making Quincy one of the healthiest cities in the world to live in. The pumping capacity is supplied by a triple expansion engine of 8,000,000 gallons daily and one compound engine of 4,000,000 gallons capacity daily, the water being filtered by 14 jewel gravity mechanical filters, therefore insuring the city over its distributing system of 45 miles of water mains, an inexhaustible supply of water as the water is derived from an intake pipe from the channel of the Mississippi River. Quincy was settled and laid out by John Wood in the year of 1821 and to his memory there has been erected a statue in Washington Park, this being the principal part of the city. Quincy has a series of 16 nicely located parks situated in different parts of the city connected by a boulevard surrounding the city, and in all aggregating 152 acres. This in connection with the Illinois Soldiers' and Sailors' Home, which contains 140 acres, makes ample room for out-door recreation. The Illinois Soldiers' and Sailors' Home, situated upon these beautiful grounds of 140 acres, is complete in every detail and has a capacity for 2,000 veterans and the average attendance is about 1,700. Quincy's Federal building and court-house are buildings worthy of any city, so is the city-hall recently erected at a cost of $140,000. The trade of the city is extensive and is distributed on several lines of railroad and the Mississippi River. Many of the streets are traversed by electric railways, the total extent of which is 27 miles, allowing people to go to all the principal business points and parks. The city is divided into seven wards. Of the public and charitable buildings the city contains two hospitals with the combined capacity of about 300 beds; 10 asylums and homes, and 33 churches, representing about all the denominations found in a community of the size of Quincy. Of public school houses there are 13, having been built at an aggregate cost of one half million dollars, with a corps of 114 teachers. The attendance of the public schools number 5,400 children. Besides these there are 12 parochial schools that have an attendance of 2,400 children with an attendance among the seven colleges located here that have an attendance estimated at about 1,500. The commercial interests of Quincy are represented by 1,500 firms with a capitalization of over $15,000,000, embracing almost every kind of manufactory. Quincy is known particularly as a strong manufacturing city, there being 8 foundries with a capitalization of $2,000,000, 7 machine shops with a capitalization of over $1,000,000, 5 carriage manufactories with a capitalization of $1,000,000, 5 flour mills with a capitalization of $500,000; also the largest steam governor plant in the world, with a capitalization of $500,000. There are also 6 breweries with a capitalization of $1,000,000, also 4 incubator factories with a capitalization of $1,000,000. There are also manufactories of furniture, plows, tobacco, organs, soap, files, and matches. Quincy is also well represented in the publishing line by 4 daily papers, besides numerous weeklies and monthlies, 19 in all. Pop. (1910) 36,587.

H. Hatch, M.D.

Quincy, Mass., city in Norfolk County; on Quincy Bay, and on the New York, N. H. & H. railroad. The city includes within its corporate limits several villages; its area is about 16¼ square miles, nearly four square miles of which are in public parks. It is bounded on the north by Neponset River, and on the south by Fore River. It was settled in 1625 and was first known as Mount Wollaston. About four years later Thomas Morton (q.v.) obtained control of the settlement and established his "New English Canaan,» «Merry Mount.» His institution of the «May Pole» and other «Idolls,» and his manner of living in general, offended the Puritans of Boston, and they thought him a dangerous man in the new country. He was arrested by Miles Standish and sent back to England. The place remained a part of Braintree until 1702 when it was incorporated as Quincy, after John Quincy. In 1888 it was chartered as a city.

The first railroad in New England was constructed here in 1826–7; it was two miles long, operated by horses, and used for carrying stone for building Bunker Hill Monument. There are many places of historic interest in and around Quincy, and some of the buildings of Revolutionary days are still in existence. Quincy came into great prominence the last quarter of the 19th century, on account of an educational movement under the leadership of Francis Wayland Parker (q.v.). Many prominent people have lived in Quincy; it was the birthplace of John Adams, John Quincy Adams, and John Hancock. The Adamses are buried under the old «Stone Temple.»

Quincy is largely a residential suburb of Boston; but the quarrying interests are still of importance. It has also a large ship-building plant, machine and tools shops. It has a city hospital, the Woodward Institute, for girls; the Adams Academy, a high school, elementary public schools, and the Thomas Crane Public Library, which contains about 25,000 volumes. The Metropolitan District System supplies Quincy with water. The government is administered under a revised charter of 1900, which provides for a mayor and council, elected annually. The school board is chosen by popular vote. The mayor appoints the heads of all departments except that of the school board. The council elects the other administrative officials. Pop. (1900) 23,899; (1910) 32,642. Consult: Adams, ‘Three Episodes of American History’; Hurd, ‘History of Norfolk County’; Pattee, ‘A History of Old Braintree and Quincy’; Wilson, ‘Where American Independence Was Born’; Adams, ‘The Centennial Milestone’; Report of U. S. Commissioner of Education, Vol. I. (1902), on the Quincy educational movement; Partridge, ‘Quincy Methods.’

Quinet, kē-nā, **Edgar**, French litterateur: b. Bourg 17 Feb. 1803; d. Versailles 27 March 1875. He was educated at the schools of Charolles and Bourg and the Lycée of Lyons. His first publication was ‘Tablettes du Juif Errant’ (1823). A visit to Germany introduced him to Herder's ‘Philosophy of the History of Humanity,’ which interested him profoundly and gave direction to his life studies. He published a translation with an introductory essay in 1827. Living at Strasburg he met Victor Cousin and Jules Michelet, the latter of whom became his closest friend. In 1829 he was chosen by the French Academy to go to the Morea as philologist attached to a commission of *savants*, and on his return in 1830 published ‘De la Grèce Moderne et de ses Rapports avec L'Antiquité.’ His republican sympathies were stirred by the revolution in July and his feelings gained expression in political pamphlets. He wrote a remarkable prose poem ‘Ahasuerus’ (1833), and later two other epics, ‘Napoléon’ (1836), and ‘Prométhée’ (1838). His purpose in these three was to represent humanity as general, individual, and religious — Ahasuerus, the race; Napoleon, the individual, and Prometheus, the martyr. In 1838 he published a reply to Strauss' ‘Life of Jesus,’ the next year was appointed professor of foreign literature at Lyons and in 1841 became professor of Southern Literature in the College of France. His Lyons lectures were published under the titles, ‘Génie des Religions’ (1842), and ‘Le Christianisme et la Révolution Française.’ His lectures delivered at the College of France attacking the Jesuits so aroused public feeling that the government closed his class-room in 1846. His republican opinions became so pronounced and his expression so outspoken that after the *coup d'état* of Louis Napoleon in 1851 he was banished from France. His exile, which lasted until after the fall of the Empire in 1870, was fruitful in such works as ‘Marnix de Saint-Aldegonde’ (1856); ‘L'Histoire de Mes Idées’ (1858); ‘Merlin l'Enchanteur’ (1860); and the Révolution Française’ (1865). Re-established in Paris, he was elected to the Chamber of Deputies and voted consistently against all monarchical reaction and for the secularization of laws. His last work, ‘L'Esprit Nouveau’ (1874), contains an expression of his social, political and intellectual creed. His complete works were published in 30 volumes (1877–82). Consult his ‘Lettres d' Exil’ (1884); ‘Edgar Quinet depuis l'Exil,’ a biography by his widow (1888–9); Heath, ‘Edgar Quinet: His Early Life and Writings’ (1881).

Quingua, kēng'wä, Philippines, pueblo, province of Bulacá, Luzon; on the Quiñgua River, seven miles from its mouth; six miles north of the town of Bulacán. It is a road centre, and is a health resort for the surrounding provinces because of its pure water. Pop. 8,860.

Quinidine. See QUININE.

Quinine, kwĭn'ēn or kwī'nīn, or **Quinina**, a drug ($C_{20}H_{24}N_2O_2$) most largely used in the cure of fevers. Technically known as a febrifuge (fever-cure), it is also a valuable tonic. Quinine is one of four important alkaloids obtained from the bark of the cinchona-tree (Peruvian bark; see BARK, PERUVIAN); the others being quinidine, cinchonidine, cinchonine (qq.v.). The curative power of these alkaloids is accurately shown by the report, dated April 1868, of a commission appointed by the British Indian government (Madras) after the suggestion of Clements R. Markham, C.B., F.R.S. Cases of fever numbering 2,472 were treated, and the result showed failures per 1,000 as follows: Quinidine, 6; quinine, 7; cinchonidine, 10; cinchonine, 23. Quinine alkaloid is seldom used, as it is very insoluble (59° F., 1,600 parts water). The salt known as quinine sulphate $(C_{20}H_{24}N_2O_2)H_2SO_4 + 7H_2O$, only is used.

The average dose of quinine sulphate for adults in the United States is 4 to 5 grains every 3 or 4 hours; in warmer and more fever-ridden countries, twice to three times this amount. The average consumption of quinine sulphate in the world at this time (1904) is 12,000,000 to 14,000,000 ounces a year, and the approximate average net cost of production is 18 cents per ounce, at which it will probably remain for a number of years, as there is very little likelihood of any material change in the processes of growing cinchona-bark or making the quinine.

Production and Manufacture.— Cinchona-trees grow from seeds planted in hotbeds or nurseries, and are transplanted when they have reached a height of 3 or 4 inches. They are then left till they attain a height of about 3 feet, when *Chinchona ledgeriana,* the species yielding the largest amount of quinine, but growing very poorly in the ground, is grafted on to the stalk of *Chinchona succirubra,* which yields little quinine, but grows very thriftily. This combination gives the rich yield of the former with the healthy growth of the latter. After the graft has healed, these young trees are again transplanted to cleared places in the jungle. They are fertilized and attended carefully for six years, when they have reached their most profitable age. They are then sawed down at the ground, and sawed into sections, and native women beat the sappy bark from the wood with mallets. (All parts of the cinchona-tree contain traces of quinine, but the bark is the only part containing appreciable quantities of it.) The bark is dried in the sun for a day or two, then it is dried by a fire. Finally it is roughly ground, packed in bundles of 100 kilos (225 pounds) each, and sent to the market.

To manufacture quinine, the bark is ground to a No. 70 powder (screens of 70 meshes to the inch), and mixed with lime-water sufficient to moisten the powder thoroughly. It is then mixed with crude petroleum and boiled about five hours, the quinine in the bark dissolving in the oil. The powder is then allowed to settle, and the oil is drawn off and washed with dilute sulphuric acid, agitated violently with jets of air. The quinine now leaves the oil and goes to the acid-water, in which it is more soluble than in the oil. The oil and water now separate upon standing, and the acid-water is drawn off and neutralized with soda, when the quinine and other alkaloids are precipitated. The alkaloids other than quinine are separated from it, and the quinine is redissolved in dilute acid-water to saturation while hot. Upon cooling, crystals of quinine sulphate are thrown out, filtered, and dried for the market.

History.— The virtues of the bark of what was afterward known as the cinchona-tree were discovered by the Jesuits in Peru about the year 1600. Prior to that date the Indians evidently knew that it had remedial powers, but they did not use it to any extent. In 1638 the Countess of Chinchon, whose husband, Don Luis Geronimo Fernandez de Cabrera Bobadilla y Mendoza, was viceroy of Peru, was cured of an intermittent fever by the use of this bark administered by her physician, Don Juan de Vega, on request of Don Francisco Lopez de Cañizares, corregidor of Loxa. Upon her return to Spain in 1640 the countess carried a supply of the bark with her, and through her it became known to the world. It was very fitting that 100 years later Linnæus should name the genus of trees bearing this bark for the countess — *Cinchona* (Linnæus erred in spelling; it should have been *Chinchona*).

The actual discovery and isolation of quinine is to be ascribed to the French chemists Pelletier and Caventon in 1820, although Gomez, a Portuguese, succeeded in isolating the febrifuge principle, which was practically quinine, in 1816. Sulphate of quinine was first made in America in 1823, and the house of Powers and Weightman, which was founded five years before this date, was undoubtedly the first to manufacture it for sale. Until about 1850 the only source of supply was found in the trees growing wild on the sides of the Andes, and as quinine had become so valuable a remedy the world over, the native forests were almost exhausted so great had become the demand for cinchona-bark. The price had reached about $20 per ounce. The Dutch, knowing that they had in Java climate, altitude, and temperature almost identical with those in Peru, determined to secure trees or seeds and try to cultivate it there. (Cinchona requires an altitude of 3,000 to 5,000 feet, tropical temperature, without much variation, from 100 to 200 inches of rain a year, and a volcanic soil.) The British government made the same attempt in India, but with poor results, because the same conditions of soil and rain do not prevail; and after about 50 years' endeavoring to raise cinchona in India and Ceylon, there only remain a few gardens owned by the government, the product of which is consumed in the army and among the natives, to whom it is sold through the post-office at cost.

The Dutch experiment, however, proved to be very successful and remunerative, although it involved almost insurmountable obstacles, loss of years of time, and lives of earnest working scientists. The trees now thrive tenfold more than even their Peruvian ancestors, for the congenial environment found in Java, together with the shrewd methods of cultivation discovered by the Dutch, the most faithful of whom has been Van Leersum, now government director of Cinchona Undertakings, who has not even left Java for a holiday in 25 years, gave yields of as high as 10 and 12 per cent; and the writer has taken bark from trees yielding as high as 16 per cent sulphate quinine, while an average of 1½ to 2 per cent was a fair yield of the Peruvian trees.

There are now about 25,000 acres of cinchona plantations in Java, producing approximately 98 to 99 per cent of the cinchona-bark supply of the world, and in a few years there will be no supplies whatever from any other quarter.

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Quin'isext Council, or Council in Trullo, council of bishops held (692) in the hall named Trullus of the imperial palace at Constantinople. The design of this council was to supplement the purely doctrinal canons of the 5th general council (553) and of the 6th (660) with canons regulating discipline; for this reason it has been called in Latin Concilium Quinisextum (Latin, *quintus,* fifth, and *sextus,* sixth), and in Greek Synodos Penthektē (Greek, *pente,* five; *hektos,* sixth). It was attended by 211 bishops, all Oriental, and its decrees have ever been repudiated by the Western Church. Among the rules of discipline enacted by this council is one declaring married men eligible tc the orders of subdeacon, deacon, and priest, but forbidding the marriage of one who is already in priest's orders.

Quin'nat Salmon, the foremost of the Pacific salmon in popular esteem and in commercial importance on account of its size, abundance, and its habit of entering the rivers in the spring. It is known scientifically as *Oncorynchus tschawytscha,* the specific name being a Latinization of that by which it was known to Russian fishermen about Bering Sea; Columbia Chinook, Sacramento and King Salmon are other names. It ascends the rivers early in spring, entering the Columbia as early as February or March, and goes to their headwaters to spawn, if not prevented, — those which succeed reaching the sources of this great watercourse about August or later. None returns alive from the spawning beds. « There is no other species of fish in the world,» says Jordan, « equalling the Chinook salmon in commercial value. Of the five species of salmon on our West Coast it is approached in value only by the blueback. It reaches an enormous size; examples have been taken in Cook Inlet weighing 100 pounds, and individuals of 40 to 60 pounds weight are not infrequent. The average weight of those taken in the Columbia River has been stated to be 22 pounds, for those of the Sacramento River 16 pounds.»

Quin'nipiac («long water land»), an Indian tribe of the Algonquian linguistic stock, and probably forming a part of the Wappinger group, formerly residing on Quinnipiac River, New Haven County, Conn. Their principal village was on, or near, the present New Haven. In 1638 they numbered about 165; in 1735 they had increased to 250; in 1768 some of them moved to Farmington, where land was bought for them, in 1774 the original settlements were reduced to 38 natives.

Quinoa, kē'nō-ạ, an annual herb (*Chenopodium quinoa*) of the order *Chenopodiaceæ.* It is a native of the Chilean and Peruvian Andes, and extends intermittently to Mexico. It grows about three feet tall, bears triangular leaves, very inconspicuous greenish flowers and large seeds. In general the plant resembles the common lamb's quarters or goosefoot (*C. album*), a well-known weed in American gardens. In South America and to some extent in Europe the plant is cultivated for its seeds, which are nutritious and are made into meal or fed to poultry. Its young tender foliage is also used like spinach, a related plant. Since it is a favorite food of certain insects it has not been profitably cultivated in California, where it was tried.

Quin'oline, Chinolin, Leucoline, C_9H_7N. Runge (1834) isolated an oily basic substance from coal tar to which he gave the name leucoline. Gerhardt (1842) obtained an oil by distilling quinine or cinchonine with caustic potash. He called it quinolein from its relation to quinine, but later the name was changed by Wöhler to quinoline. Hofmann (1843) showed that leucoline and quinoline were identical. It occurs also in bone-oil, and other plant alkaloids than those mentioned above give it with caustic potash. Usually made by the interaction of glycerine, sulphuric acid, aniline and nitro-benzene, and an oily liquid, colorless when pure, but becoming dark on exposure to the air, it possesses a penetrating, disagreeable odor, boiling point 239° C., is slightly soluble in water and has a strong antiseptic action. It is a basic substance, forming soluble and easily crystallizable salts with acids. It is used to some extent as an antiseptic and in the preparation of a few dyes.

Quin'one, in chemistry, a class name which is applied to bodies that may be considered as derived from aromatic compounds by the replacement of two « ring » hydrogen atoms by two oxygen atoms. All the compounds of this class are colored and give colorless hydroquinones when reduced. Most of the quinones have the oxygen atoms in the «para» relations to each other. A very few «ortho» quinones are however known. The simplest and first known of this class is ordinary quinone or benzoquinone $C_6H_4O_2$; obtained by oxidation of quinic acid, but now usually prepared by oxidation of aniline with a mixture of dilute sulphuric acid and potassium bichromate. Its golden yellow prismatic crystals possess a peculiar pungent odor, and stain the skin yellow. Soluble in water or alcohol, they are volatile with steam and turn dark on exposure to the air. On reduction it gives hydroquinone $C_6H_4(OH)_2$, a soluble colorless crystalline body that is used extensively as a photographic developer. Quinone is a very active chemical substance, forming a large number of derivatives. Another very valuable member of this class is anthraquinone, $C_6H_4C_2O_2C_6H_4$, a yellow crystalline body obtained by oxidation of anthracene. Related to it and obtained from it is the very valuable dye alizarine, the substance to which madder owes its value as a dye-stuff. See ALIZARINE.

Quinquagesima, kwĭn-kwạ-jes'ĭ-mạ, **Sexagesima, Septuagesima,** the 1st, 2d and 3d Sundays before Lent. The words mean, respectively 50th, 60th and 70th, and in the Roman calendar the names of the three Sundays are *Dominica Quinquagesimæ, D. Sexagesimæ,* and *D. Septuagesimæ,* respectively. The use of the words is ancient, dating at least from the 7th century, but their meaning is obscure. Alcuin (9th century) suggested the numeration of 70 days from *Dominica Septuagesimæ* down to *Pascha Clausum,* the octave of Easter: but that leaves the other two names unexplained. Another explanation offered by Alcuin was that these two names are formed on the analogy of *Quadragesima* (Lent), being one and two weeks before the first Sunday in Lent: a false analogy, which assumes 7 to be equal to 10: but false as it is, it led to calling the second week of Lent *Tricesima* (thirtieth) and the third *Vicesima* (twentieth).

Quinquartic'ular Controversy. See ARMINIANISM.

Quinsy, an acute inflammation of the tonsils; acute parenchymatous tonsillitis. It is attended by fever, pain, headache, difficulty in swallowing (dysphagia), and frequently by suppuration. One attack seems to predispose to another. It is not uncommon for individuals to have attacks year after year at about the same time of the year. Disturbances of the digestive organs — diarrhœa, constipation, loss of appetite, nausea, vomiting, etc., are predisposing causes. Sudden changes of weather, exposure to damp and cold, especially after coming out of a heated room, are exciting causes.

Quinsy sets in with an uncomfortable feeling in the throat, and fever sometimes high, preceded at times by chilliness. The patient is restless and irritable, the tongue becomes covered with a thick yellowish coating, the breath is unpleasant, saliva drools from the mouth, there is difficulty in opening the mouth, swallowing is attended with great effort and pain, and sometimes food returns through the nose. Pain may be severe most of the time, shooting toward the ear upon the affected side. Swelling externally behind the ears and involving the glands of the neck may be marked. A thick tone of the voice, thirst, headache, snoring, and dryness of the throat are common symptoms. Sometimes breathing is impeded, especially if both tonsils are involved. On examination of the throat one or both tonsils are seen to be bright red and sometimes covered with patches of a yellow secretion. The soft palate is red, greatly swollen, and œdematous, as is also the uvula, which not infrequently adheres to the tonsil. Quinsy may terminate either in resolution or suppuration. If resolution is to take place, in about four or five days the inflammation begins to subside, and the patient in from ten days to a fortnight may resume his ordinary employments. If suppuration is to occur, the tonsilar swelling becomes greater, and if both tonsils are inflamed they may meet, causing great discomfort. When pain and discomfort become almost unbearable, an inflamed tonsil generally breaks, and great relief and speedy convalescence follow.

Occasionally, if the disease is taken at the outset, it can be aborted by a purgative, or an emetic, and the use of one or two drops of tincture of aconite every hour. If it continues in spite of early treatment, it will probably run its course, though much can be done to palliate. Keep the patient quiet (sometimes in bed), and give hot or cold liquid foods, whichever he can swallow best. Washing out the throat with hot water every hour may be comforting, as also may inhalations of the steam of hot water, cooled by passing through a towel or a long tube. Saline laxatives are useful; so are hot compresses about the neck. Ice and cool drinks have an efficacious value. Local applications and the use of medicines and stimulants should be left to the judgment of the physician. Abscesses should be opened (not left to mature) and astringent gargles afterward used.

Quint, kwĭnt, **Alonzo Hall**, American Congregational clergyman: b. Barnstead, N. H., 22 March 1828; d. Boston, Mass., 4 Nov. 1896. He was graduated from Dartmouth College in 1846, from Andover Theological Seminary in 1852, and was ordained to the ministry in 1853. He became chaplain of the 2d Massachusetts volunteers in 1861 and served with them until 1864. After the war he was pastor of several Congregational churches successively, edited the 'Congregational Quarterly' in 1859–76, and was author of: 'Army Notes' (1864); 'Records of the 2d Massachusetts Regiment, 1861–5'; etc.

Quin'tain, an apparatus used in a military sport or exercise by men on horseback, formerly practised in England to try the agility of the country youth. The quintain was an upright post with a cross-bar on the top of it, turning round on a pivot. To one end of the bar was suspended a bag of sand, the other end was broad and flat. The horseman had to ride tilt at the flat end with his lance, and endeavor to strike it and pass on before the bag of sand could whirl round and strike him on the back.

Quin'tal, a weight of 100 or 112 pounds, according to the scale used. See WEIGHTS AND MEASURES.

Quintana, Manuel José, mä'noo-ĕl hō-sā' kēn-tä'nä, Spanish poet: b. Madrid, Spain, 11 April 1772; d. there 11 March 1857. He was educated in the university at Salamanca, studied law, engaged in practice at Madrid, where he occupied several government offices, and soon turned his attention to literature. He was author of almost all the manifestos and proclamations issued in the war of independence and his patriotic poems soon won for him great popularity. He edited the journal 'Variedades de Ciencias, Literatura, y Artes,' founded the 'Semanario Patriotico,' and urged upon the people the necessity for resisting Napoleon. After the restoration he was imprisoned in 1814–20, and then was released by the revolution. He lived in retirement from 1823 until 1833 when he was appointed preceptor to the infant queen, Isabella. In 1835 he was elected senator and was afterward highly esteemed at court. He was one of the leading poets of his time, attaining a European reputation. As a historian he is well known by his 'Vidas de los Españoles célebres' (1807–34). His complete works are published in Rivadevieyra's 'Biblioteca de autores españoles' (Vol. XIX., 1852); and by Rojas (1897–8).

Quintet', a musical composition for five instruments or voices, accompanied or unaccompanied. (1) Quintets for stringed instruments have been written much less frequently than quartets, by reason of their complexity. Boccherini, nevertheless, wrote 125. Among famous string quintets are Beethoven's two in C and E flat, Mendelssohn's in B-flat, and Schubert's in C. There are various quintet combinations, including brass and wood-wind, as Mozart's in E-flat for oboe, clarinet, horn, bassoon, and piano. (2) Vocal quintets are also rare, but very effective. The most notable modern example occurs in Wagner's opera of 'Die Meistersinger.'

Quintilianus, kwĭn-tĭl-ĭ-ā'nŭs, **Marcus Fabius**, Roman rhetorician: b. Calagurris (Calahorra), Spain, probably between 35 and 40 A.D.; d. about 118. He was educated at Rome and about 69 began to practise as an advocate. Subsequently he became a teacher of rhetoric. Domitian bestowed on him the consular rank. His first important treatise, 'De Causis Corruptæ Eloquentia,' is no longer extant. His great work, 'Institutio Oratoria,' was written about 93, and embraces a statement of his theory of education together with a discussion of the principles, scope, and matter of oratory; also its manner under the general term style. The best editions of Quintilian are those of Burmann (Leyden, 1720), Capperonier (Paris, 1725), Gesner (Göttingen, 1738), Spalding and Zumpt (Leipsic, 1798–1829), and Halm (1868–9). There are also special editions of the 10th book, among which are those of Bonnell (1851), Kruger (3d ed. 1888), Peterson (1891); this book criticizes Greek and Latin literature, from the point of view of the orator and its usefulness in forming a vocabulary.

Quintilius, kwĭn-tĭl'ĭ-ŭs, **Aurelius Claudius**, Roman emperor, 270 A.D. He was a brother of Claudius II., and at the latter's death was elevated to the throne, but as the army at Sirmium had elected Aurelian emperor, Quintilius, seeing himself deserted by his followers, committed suicide. He seems to have been a man of unblemished character and to have possessed the high attributes of his brother. The length of his reign is usually placed at 17 days, but the large number of his coins extant indicates that he held the office for some months.

Quin'tuple Alliance. See QUADRUPLE ALLIANCE.

Quin'tus Cal'aber, or **Smyrnæus,** Greek poet: belonging probably to the end of the 4th century A.D. His surnames are derived from the discovery of his poem in Calabria (in a convent at Otranto), and his mention of Smyrna as the place of his residence. His poem, *Παραλειπόμενα 'Ομήρῳ*, ('Supplement to Homer'), is a continuation of the 'Iliad,' in which he imitates, with very little originality, the poets of the epic cycles. A critical edition of this, by Tychsen, with remarks by Heyne (1807), was published by the Bipont Society. There is also an edition by Köchly (1853).

Quintus Curtius. See CURTIUS, RUFUS QUINTUS.

Quip'o, a cord about two feet in length, tight-spun from variously colored threads, and to which a number of smaller threads are attached in the form of a fringe: used among the ancient Peruvians and Mexicans for recording events, etc.

Quir'inal, one of the hills of Rome, not included in the ancient Septimontium, or «City of the Seven Hills,» but part of the four regions of the city, and included in the Servian Wall. Next to the Palatine and Capitoline, it is the oldest and most famous part of the city. The temples of Flora, Salus, and Quirinus were on the Quirinal, and also the baths, or the great thermæ, of Diocletian and Constantine. Pope Gregory XIII. began here the erection of a summer residence which was completed by Paul V. Victor Emmanuel took possession of it in 1870, and it has since been the residence of the king of Italy. One of the principal treasures of the palace is the ceiling decoration of one room,— painted by Overbeck (q.v.). The subject is 'The Flight of Pius IX. in 1848.' Other treasures are an 'Annunciation,' by Guido Reni, and several other works of art. See ROME.

Quirinus, kwĭ-rī'nŭs, Roman deity, ranking next to Jove and Mars. His origin appears indistinct but he is represented as a war god prepared for battle in times of peace. The third great flamen was assigned to his worship and his temple stood on the Quirinal Hill near the Porta Quirinalis. He was honored by the Colline Salii and a new building was erected in his honor 293 B.C., which after its destruction by fire was replaced with an imposing structure by Augustus 16 B.C. In the 1st century B.C., however, the belief that Quirinus was Romulus raised to the rank of a divinity gained credence and this opinion was favored by Cæsar and Augustus. His annual festival was celebrated on 17 January, the date of the supposed translation of Romulus to heaven.

Quirites, kwĭ-rī'tēz, originally the inhabitants of Cures, a Sabine town, and a name afterward applied to that portion of the Sabines who at an early period dwelt in Rome. Quirites being applied to them in their civil capacity, while Romani was applied to them in their political and military capacity. On this account it was regarded by the soldiers as a great indignity to be addressed as Quirites, and Julius Cæsar on one occasion quelled a rising mutiny among his troops merely by scornfully haranguing them under the appellation of Quirites. But the contumelious sense of this name had banished before the time of the Augustan age.

Quirk, a term commonly used in architecture and carpentry; (1) A sudden turn; applied to a form of molding in which an acute recess separates the molding proper from the fillet or soffit. It is much used between moldings in Gothic architecture; in Grecian, and sometimes in Roman, architecture ovolos and ogees are usually quirked at the top. (2) A projecting fillet on the sole or side of a grooving plane, which acts as a fence or a gauge for depth or distance. (3) A piece taken out of any regular ground-plot or floor, so as to make a court, yard, etc.; thus, if the ground plan were square or oblong, and a piece were taken out of the corner, such piece is called a quirk.

Quiroga, kē-rō'gä, **Juan Facundo,** Argentine politician and soldier: b. La Rioja, Argentina, 1790; d. near Cordova, Argentina, 1835. He was educated in Spain and on his return to Argentina organized a band of rude soldiery which made him practically the ruler of northeastern Argentina in 1820. In 1827 he appointed a governor of La Rioja, secured the election of Dorrego as president and though defeated by General Paz in 1830 became governor of Buenos Ayres in 1834. He was assassinated in the following year.

Quit and **Goal,** in astronomy, two terms introduced by Prof. H. A. Newton, of Yale University, to define the two points opposite each other in the heavens toward one of which the earth is at the time moving in its orbit round the sun and from the other receding.

Quit-claim, in law, a deed of release; an instrument by which some claim, right, or title, real or supposed, to an estate, is relinquished to another without any covenant or warranty, express or implied. See DEED.

Quitch. See COUCH GRASS.

Quitman, kwĭt'man, **John Anthony,** American politician and soldier: b. Rhinebeck, N. Y., 1 Sept. 1799; d. Natchez, Miss., 17 July 1858. He studied law and in 1821 removed to Natchez, Miss., where he established a successful law practice. He was elected to the legislature in 1827; was chancellor of the superior court of Mississippi in 1828–31 and in 1832–4; was president of the State senate in 1835; in 1836 served as ex-officio governor of the State and in 1839 was judge of the high court of error and appeals. Interested in the cause of Texan independence he labored earnestly in its behalf, receiving at the outbreak of the Mexican war the rank of brigadier-general of volunteers. He distinguished himself in the battles at Monterey, Vera Cruz, Alvarado, and Chapultepec, was promoted major-general of volunteers and received from Congress a sword and a vote of thanks. He was appointed governor of the City of Mexico by General Scott and on his return was elected governor of Mississippi in 1850, which office he resigned in the following year when accused of complicity with the Lopez-Cuban expedition, a charge of which he was acquitted. In 1855–8 he served in Congress, where he was an ardent supporter of states rights. Consult Claiborne, ‘Life and Correspondence of John A. Quitman’ (1860).

Quito, kē'tō, capital of the Republic of Ecuador, situated only a few miles south of the equator, but at a height of more than 9,000 feet above sea-level. Climatic results of proximity to the equatorial line are modified and nearly equalized throughout the year by those of altitude; the temperature is, therefore, spring-like. It is, however, an inaccessible inland place; until 1903 (see Ecuador) neither railway nor highway connected it with the seacoast. A part, at least, of the journey to Guayaquil, 165 miles away, was usually made on mule-back, along a mere bridle-path which crossed the breast of Mt. Chimborazo at a height of 14,000 feet; and the rarefaction of the atmosphere at that altitude can seldom be supported without discomfort. For the transportation of freight from the port to the interior two or three weeks have hitherto been required. Owing to its remoteness and the lack of highways, the city is visited by few strangers, and has no good hotels, no carriages, or wagons. Yet the streets are lighted by electricity, and the list of public institutions devoted to education, the Roman Catholic church, and the government, is quite impressive, including an astronomical observatory, botanical garden, school of agriculture, and other adjuncts of a «central university,» with faculties of belles-lettres, science, law, and medicine. The architecture in general is that of a country subject to earthquakes — low and substantial. Features deserving special mention are the beautiful park called the Alameda, and the Sucre Theatre. The estimate of population (probably much too liberal) in semi-official publications is 80,000. See also Ecuador, *History and Political Divisions*.

Quivira, kē-vē'rā, a «province,» reputed to have been populous and rich in gold and other things, of which Francisco Vasquez Coronado, the Spanish explorer, received news from a plains Indian, known as the «Turk,» while in winter quarters on the Rio Grande in New Mexico in 1540–1. Coronado started from Pecos pueblo in New Mexico, with his army, guided by the «Turk,» in the spring of 1541, and after long wandering over the buffalo plains of Texas, sent the larger part of his force back to New Mexico and continued his journey due northward for 35 or 40 days, encountering the first settlement of Quivira about the present Great Bend, Kan. The province was found to consist merely of a group of villages, composed of grass lodges and inhabited by a tribe, recently identified as the Wichitas, which raised corn and hunted the buffalo. Coronado put the «Turk» to death, and after exploring the country for several months, returned by a more direct route to New Mexico. Coronado's disappointment having become forgotten, the name Quivira lingered in the minds of later Spanish explorers of the Southwest and grew to be the watchword of an unexplored Eldorado. After the abandonment of the Indian pueblo of Tabirá, in eastern New Mexico, about 1675, the idea of Quivira and its supposed wealth was transferred to the ruins of the New Mexico village, and the name «Gran Quivira,» then applied to it, has since been popularly retained. Consult Hodge, ‘Coronado's March to Quivira,’ in ‘Brower's Memoirs of Explorations in the Basin of the Mississippi’ (1899).

F. W. Hodge,
Smithsonian Institution, Washington, D. C.

Quixote, Don. See Don Quixote; Cervantes.

Quo Vadis, kwō vä'dĭs, a popular historical novel by the Polish novelist, Henryk Sienkiewicz, published in 1895 and familiar to American readers through the translation by Jeremiah Curtin. It deals with the history of Rome in the time of Nero. Its curious title has reference to an ancient legend, which relates that Saint Peter, fleeing from Rome and from crucifixion, meets his Lord Christ on the Appian Way. «Lord, whither goest thou?» (Domine, quo vadis?) cries Peter. «To Rome, to be crucified again,» is the reply. The Apostle thereupon turns back to his martyrdom.

Quoin, koin (French, *coin;* Latin, *cuneus*, a wedge), a technical word for a wedge; (1) in artillery, the wedge used to elevate and depress a cannon or other piece of ordnance; (2) in printing, the wedges used to fix pages of type within the chase; (3) in architecture the term is applied to any external angle, but especially to the angular courses of stone projecting beyond the plane surface of the wall at the corner of a building, and specifically designated rustic quoins.

Quoits, kwoits, a game somewhat resembling the throwing of the discus among the ancients; only the discus was flat, while the quoit is ring-shaped. (See Discus.) The quoits are made of metal, usually iron, and are comparatively thick at the inner edge of the ring, but sharp enough at the outer edge to stick in soft clay when properly thrown. In size they vary from 8 to 9¼ inches. The game is played on a ground from 18 to 24 yards in length, at each end of which a pin called a hob is fixed in the ground to serve for a mark. The object of the game is to throw the quoits from one end of the ground to the other so as to make them stick in the ground as near the hob as possible. The best shot, called a ringer, is when the quoit surrounds the hob. The players are divided into sides, and each player has two quoits, which he delivers in succession. The winning side counts one for each quoit that it has nearer the hob than the nearest of the losing side, and if it has a ringer it counts two for it. The rules as to the size of the quoit, the distance between the hobs, and other particulars, vary with different players. In the United States quoits are generally played with cast-off horseshoes.

Quoratean (kwō-rā-tē'ạn) **Indians**, an American linguistic stock, comprising the Kworatem and Karok tribes, from the former of which the stock derives its name. The tribes occupy Lower Klamath River from the mountains a little above Happy Camp to the junction of the Trinity, and Salmon River from its mouth to its sources, in northwestern California.

Quorum, in old English law, a collective name for those justices of the peace whose presence is necessary to constitute a bench. Also such a number of officers or members of a body as is competent by law or constitution to transact business.

R

R the eighteenth letter of the English and other alphabets derived from the alphabet of the Latins. The corresponding letter of the Greek alphabet, rho, has the form Ρ, ρ, which is the q of the ancient Phœnician alphabet, with the loop turned to the right; in some very ancient Greek Italiot inscriptions occurs the form R which was adopted by the Romans. R is classed as a liquid or semivowel with *l, m* and *n*. Its normal sound is doubtless either the *trill* produced by vibration of the tip of the tongue raised toward the front palate, or the *burr*, which is produced by a vibration of the lower part of the tongue and the uvula; the trill is heard in the speech of the Latin nations — Italian, French, and Spanish; the burr in that of the Germans and Scandinavians. In present English speech the *r* is sounded with a very faint trill or quite without a trill, save in the pronunciation of the people of certain counties of England, who produce it with a guttural vibration; in the pronunciation of this letter by the Scotch and Irish the trill is distinctly heard. When *r* begins a syllable and when it follows a consonant,— as in *race, trap*, it is distinctly a consonant; but in other situations, as in *nerve, hard, never*, it is really a vowel sound. In the faulty or affected pronunciation of certain classes *r* becomes equivalent to *w*, for example, *vewy* for very. The two liquids or semivowels, *r* and *l*, are sounded when the voice is modified by certain positions of the tip of the tongue relatively to the front palate; hence the two letters are freely interchanged between one language and another and within the vocabulary of one language; Spanish *azul* is English azure; *paralysis* becomes palsy; from *parabola* comes, indirectly, palaver. There are races or peoples who are unable to pronounce the *r* with either the trill or the burr or even with the slight vibration heard in English speech; in such case *l* takes the place of *r*. When in Greek a word or syllable begins with *r* that *r* is always aspirated; and the ancient Romans represented this aspiration by inserting *h* after the *r;* this *h* we retain, though we recognize no difference between the *rh* of *rhabdomancy* and the simple *r* of rabid. In many English words the *r* found in their Anglo-Saxon originals is dropped; for example, *sprœcan* becomes speak; on the other hand, we insert *r* in words which in their ancient form were without it; for example, Anglo-Saxon *brydguma* becomes bridegroom; and French *cartouche* becomes cartridge.

Ra, rä. See Re.

Ra-ma's Bridge. See Adam's Bridge.

Raab, räb, **Johann Leonhard,** German etcher and line-engraver: b. Schwaningen, near Anspach, Germany, 29 March 1825; d. 1899. He was educated at Nuremberg and at the academy in Munich, and received an appointment as professor of engraving at the latter place in 1869. His work includes engravings after Raphael, Titian, Veronese, Kaulbach, Lessing, Schwind, Ramberg, and others, besides a collection of 50 etchings reproduced from the most notable works in the old Pinakothek at Munich.

Raab (Györ, dyėr), Hungary, capital of a province of the same name, situated at the confluence of the Raab with a minor branch of the Danube, 70 miles southeast of Vienna, a position uniquely advantageous from both a military and commercial viewpoint. Its importance dates from early Roman occupation. A considerable trade is carried on in grain, tobacco, and horses, and in manufactures of woolen cloth and cutlery. In 1809 the combined Austrian-Hungarian forces were defeated here by the French troops under Eugene Beauharnais. Pop. about 30,000.

Rab and His Friends, a short story by Dr. John Brown, an Edinburgh physician, published in 1855. Rab's friends are his master and mistress, James Noble, the Howgate carrier, and his wife Ailie. Perhaps no truer, more convincing dog character exists in literature than that of ugly, faithful Rab. The pathos in the simple lives of himself and his friends is heightened in the tinge of Scotch dialect, as well as by the author's wise self-restraint.

Rabanus, rä-bä'nūs, or **Hrabanus, Maurus,** Carolingian prelate: b. Mayence about 776; d. there 4 Feb. 856. His education was obtained in the cloister school of Fulda, and later at Tour, where his instructor, Alcuin, surnamed him Maurus after the legendary founder of the order of St. Benedict in France. He became the head of the school at Fulda, and in 822 was elected abbot of the monastery. In 842 he resigned and retired to Petersburg, but came again into public life in 847, when he was elected archbishop of Mayence. He was one of the bitterest of the opponents of the monk Gottschalk, the originator of the predestination controversy in the 9th century. His literary activity was considerable, resulting in commentaries on the Old Testament, on the Gospels of St. Matthew and St. John, and the Pauline Epistles, devotional books, homilies, hymns, polemics, and a Latin-German Glossary to the Bible. His 'Opera Omnia' are comprised in Migne's 'Patrologiæ Cursus Completus,' reprinted from Colverino, edition of 1627. This edition contains his life by the monk Rudolph, and by Johann Trithemius. Consult studies by Spengler (1856), Köhler (1870), Richter (1882).

Rabát, rä-bät (Ribát'), or **Abbát,** also known as New Sallee, Morocco, in the province of Fez, on the Atlantic coast, 62 miles west of Mequinez. It stands on a rocky plateau, and is surrounded by massive reddish-brown fortifications. A conspicuous feature from the sea is the Hasan Tower, a minaret 180 feet high, the remnant of an ancient mosque. Rabát's manufactures are carpets, woolen, cotton, and leather goods. The Sallee pirates formerly built their ship at Rabát. Pop. 30,000.

Rabba, rä'bä, Sudan, in the kingdom of Gando (Northern Nigeria), on the left bank of the Niger; carries on an active trade in slaves, and ivory, and woolen goods. Pop. about 40,000.

Rabbi, a title of honor among the Hebrews; «my teacher,» «master.» John expressly states that the word was equivalent to «teacher» (Greek, *didaskalos*, rendered in the Authorized Version «master»; John i. 38). There is another form of title, *rabboni*, found in the New Testament. The form rabban, the Chaldaic form of the Hebrew «rab,» was considered the most honorable, and was only applied to seven persons. Rabbi was also looked upon as a higher title than rab. It is supposed that this title first came into use at the period immediately preceding the birth of Christ. In the time of our Lord it was applied generally to all religious teachers, and hence sometimes to Christ himself. Now the term rabbi is applied to regularly appointed teachers of Talmudic Judaism. Since 1831 these have in France been salaried by the state. Their duties are not only to give instruction in the Talmud, but also to draw up deeds of marriage and divorce, to examine butchers, and to give their opinion as to what is legal and what is illegal in the Jewish ritual.

Rabbinical Language, that form of Hebrew in which the Jewish scholars and theologians of the Middle Ages composed their works. See JUDAISM—HEBREW LANGUAGE, JEWISH LITERATURE; etc.

Rabbinical Learning and Literature. See JUDAISM—JEWISH LITERATURE; HEBREW LANGUAGE; JEWISH PHILOSOPHICAL WRITERS; etc.

Rabbinical Legislation. See JUDAISM—THE SPIRIT OF RABBINICAL LEGISLATION.

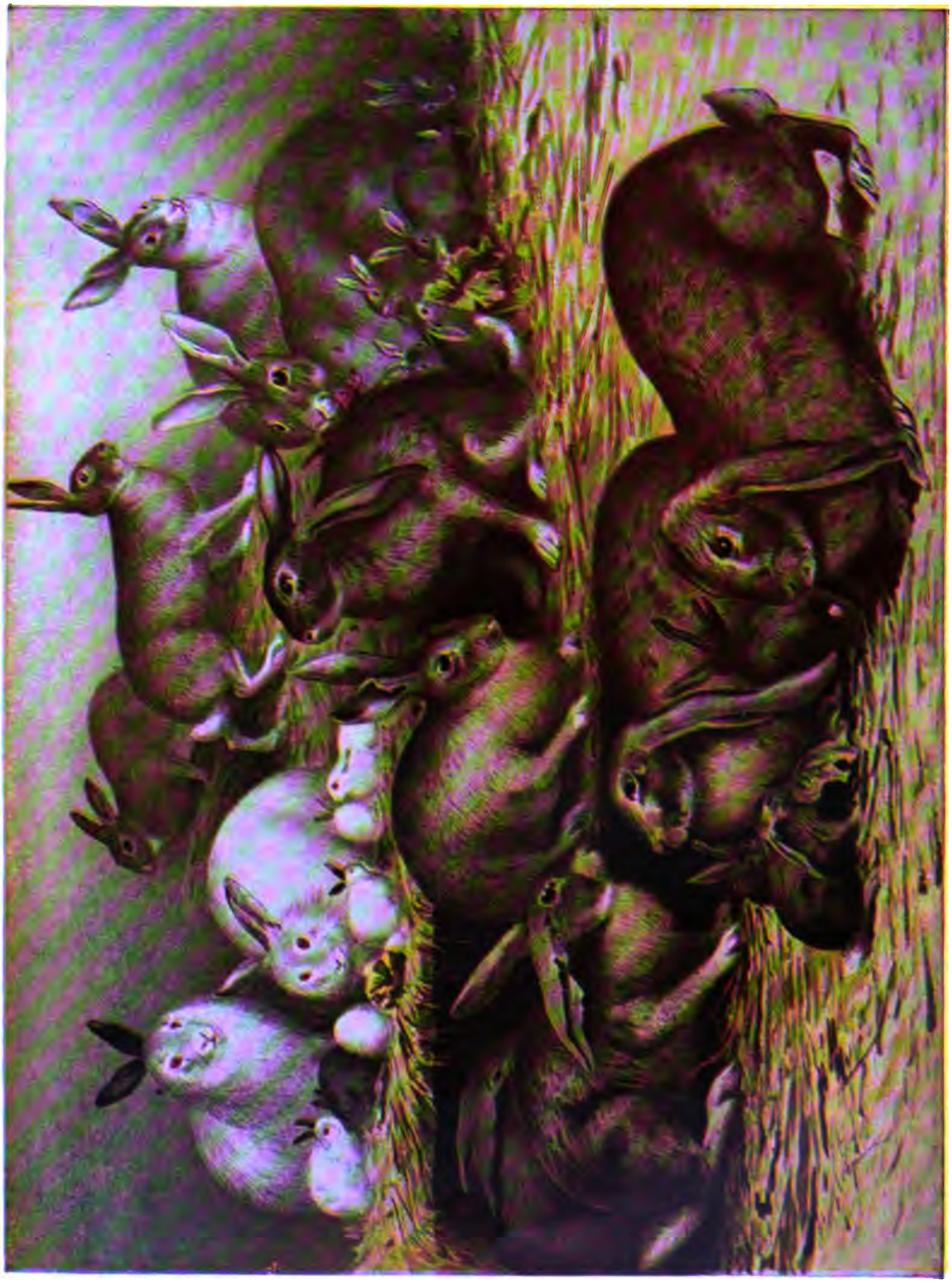
Rabbit, a name when properly used, restricted to a single species (*Lepus cuniculus*) of the rodent family, *Leporidæ*, to which the native American hares (q.v.) also belong. The rabbit is of European origin, and, although found wild in many places, is better known in the domesticated or semi-domesticated state in which it has been introduced into the United States. Although the habits of the rabbit afford the best distinction from the hares, the wild species exhibits some structural characteristics, among which are its generally smaller size, the shorter ears of uniform brown color, and the shorter limbs. The hind legs in the hares are proportionally longer than in the rabbits, and the eyes are larger and more prominent than in the latter animal. The face is also narrower and the skull lighter in the rabbit. The rabbit's fur in its native state is of a nearly uniform brown color, while under domestication the color may become pure white, pure black, piebald, gray, and other hues. The texture of the fur also changes under domestication.

Unlike the hares, which construct only simple nests or forms, the rabbit lives permanently in underground burrows, large colonies of which are often to be found in some dry sandy bank overgrown with furze or brush, or other similar locality. Such «warrens» are often specially set apart for them in order that they may breed and multiply for the market, their flesh being excellent as food, and their fur and skins of value. The burrows are irregularly disposed, and communicate freely with each other. Rabbits are extremely prolific, and begin to breed when about six months old. They may breed six or eight times a year, producing from five to seven or eight at a birth.

The parturient rabbit excavates a special burrow or tunnel for herself in which to give birth to and shelter her progeny, the nest being lined by down plucked from her own body. The young are hairless when born, and have their eyes closed. The eyes open about the tenth or twelfth day. These animals feed on tender grass and herbage, and sometimes do great damage to young trees by stripping them of their bark.

These animals grow exceedingly tame and domesticated, and may exhibit no small degree of intelligence. They are snared, taken by ferrets and nets, or may be shot. Rabbits are subject to certain diseases, such as rot, parasitic worms, and a kind of madness. The original home of the rabbit is believed to have been those parts of Europe and Africa around the western half of the Mediterranean, where it still abounds, but it is now widely spread throughout temperate western Europe, and has been conveyed by man to such distant lands as Australian colonies, Tierra del Fuego, and the Falkland Islands. In Australia and New Zealand it has multiplied so enormously as to have become a serious pest to the colonists, causing immense loss and damage by eating up the pasture intended for sheep and cattle. Various methods of extermination have been tried against them, but as yet none have had more than a moderate success. Large numbers are now killed and exported as food, frozen or otherwise preserved, and millions of skins are annually shipped to Europe and the United States. In some parts of South and Central America, and especially in Jamaica, the domestic rabbit has been introduced and established in the wild state. Darwin records several cases where quite distinct races of rabbits have resulted from their isolation on islands. An Asiatic species (*L. hispidus*) is closely related to the European rabbit, and a so-called tailless rabbit (*Romerolagus*) has recently been described from the region of Mount Popocatapetl in Mexico. It is peculiar in the possession of well-developed clavicles. All the domestic breeds of rabbits appear to have been derived from the feral species of southern Europe; and have been but little influenced by occasional crosses with hares. The Chinese, as early as the time of Confucius, appear to have bred rabbits for sacrificial purposes; and domesticated varieties are mentioned in classical Greek and Roman writers. The most noteworthy change under domestication has been the great increase in size and weight, the latter having been raised from

DOMESTIC RABBITS.



1. Wild Rabbit. 2, 3. French Rabbits. 4. French Lop-Ear. 5. Norman Rabbit. 6. Angora Rabbit.

3 pounds in the wild rabbit to as much as 18 pounds in the Flemish giant. This variety is bred chiefly for food, but for this purpose is less esteemed than the Belgian "hare," so-called because of its large size and hare-like color, and the unfounded belief that it originated from a cross between the hare and rabbit. The qualities which recommend the Belgian variety for market breeding are its extreme fecundity, the ease with which it may be kept in confined quarters, its rapid growth, so that it is ready for eating in about four months after birth, and the similarity of flavor of the young to the wild rabbit. A wave of enthusiasm for Belgian hare breeding passed through this country a few years ago, but has largely subsided, though many large rabbitries continue to supply the cities, particularly in the west. Of the purely fancy varieties the lop-ear is the most remarkable; the external ears in fine specimens measure 23 or even 24 inches long and 6 inches wide. The Angora, which originated in Asia Minor, has the beautiful long, silky white hair peculiar to several animals of that region, and there and in parts of Europe is bred for its hair, which is clipped and woven into underclothes, etc. Other varieties are peculiar chiefly in color. For methods of breeding, etc., consult Knight, 'The Book of Rabbit,' (London, 1889); Rayson, 'Rabbits,' (London, 1889); Carnegie, 'Practical Game Preserving'; for history, variations, habits, etc., Darwin, 'Animals and Plants under Domestication', Vol. I. (New York, 1868); Palmer, 'Jack Rabbits of the United States', (Washington, 1896); Reports of the Royal Commission of Inquiry on the Extermination of Rabbits in Australasia, especially that of 1890.

Rabbit-fish, in the Southern United States, a globe-fish (q.v.) of the genus *Lagocephalus*. In Bermuda and other islands of the Middle Atlantic, a common market-fish, caught in deep water. It is a rather large, reddish crown escolar (*Promethichthys prometheus*), and owes its name to its prominent front teeth.

Rabelais, François, frän-swä räb-ē-lā, French author; b. Chinon, Touraine, 1483; d. Paris 9 April 1553. He entered the Franciscan order at Fontenay-le-Comte, in Poitou, and being at first freely permitted to study, acquired Arabic, Hebrew, and Greek, and read omnivorously on almost all subjects. Eventually, however, the Franciscans came to distrust the new learning. Rabelais was deprived of his books, and in disgust fled the monastery. Shortly afterward he obtained permission of Clement VII. to enter the Benedictine order, but in no long time quitted this brotherhood also, and began to traverse the country under the habit of a secular priest. His biographers have found it difficult to follow him during this period of his life, but it seems that in his wanderings he cultivated all the sciences of the day, and especially philology, with assiduity, and that in this he exhibited powers of acquisition such as few have possessed before or since. In 1530 he was enrolled as bachelor in the faculty of medicine at Montpellier, where he lectured in 1531–2, although it was not till 1537 that he obtained the degree of doctor. In 1532 he went to Lyons, where he published 'Hippocratis et Galeni Libri Aliquot' (1532), and the first germ of his 'Gargantua' (1532), of which, according to his own account, more copies were sold in two months than of the Bible in nine years. He was made physician to the Lyons Hospital, and was a member of the Société Angélique, a coterie of scholars that had gathered around the workshop of Gryphius, the printer. This first specimen of the power of Rabelais in the style that has rendered him famous has all the grotesque humor, amounting even to buffoonery, and the variety of marvelous adventures of his later works of the kind, but wants the delicate raillery, the sustained allegory, and profound philosophy, which most students of Rabelais find in the subsequent versions of 'Gargantua,' and still more in the last three books of 'Pantagruel.' The first part of 'Pantagruel' appeared under the anagrammatic pseudonym of Alcofribas Nesier, within a year or so after the first work, and its success was such that it passed through three editions in one year. In 1534 he accompanied, probably as physician, Cardinal Jean du Bellay, on an embassy to Rome. Not long after he is found again at Lyons, where the 'Gargantua,' as we now have it, first saw the light in 1535. In 1536 he was again at Rome, and on this occasion obtained from the Pope absolution for having neglected to enter a Benedictine house and other delinquencies. In the year following he is known to have been practising his art at Paris, but his love of wandering had not yet ceased, and his place of abode for the next eight or nine years was as unsettled as it had been during any previous part of his life. In 1546 he was probably in Paris, when the third book of his 'Pantagruel' appeared. In this the fantastical and trivial adventures that crowd the previous books give place in a great measure to regular dissertations, in which all the great moral and social questions of the day are discussed with the gaiety and irony peculiar to Rabelais, and with a freedom that roused the suspicion of the clergy, who endeavored to have it suppressed. The favor of the king secured the free publication of this book, but it was with more difficulty that a license was obtained for the fourth book from the next king (Henry II.), who had succeeded Francis in 1547. A mutilated edition of this appeared surreptitiously at Lyons in 1547. The license to publish was not obtained till 1550, and it was only in 1552 that a complete and authentic edition of the book appeared. Rabelais was installed in the cure of Meudon, which he had had bestowed on him by his former patron, Jean du Bellay, and here he seems chiefly to have resided during the remainder of his life, resigning two months before his death. He left at his death the whole of the fifth book of 'Pantagruel' in manuscript. A sixth book was intended to be added, but there is only a fragment of it indicating its subject, 'Les Noces de Panurge.' His enemies busily pointed out impieties, and he once fled to Metz to escape danger. Rabelais was one of the first to give flexibility and finish to the yet rude and harsh language of his country. Boileau calls him *La raison en masque*, and Rousseau, *Le gentil maître François*. His house was the resort of the learned; his purse always open to the needy; and his medical skill employed in the service of his parish. His work cannot now be easily understood without a glossary and commentary. It has been widely regarded, especially in France, as a treasury of wisdom, wit, and shrewd sense.

Among the best editions of the 'Gargantua' and ‹Pantagruel› may be mentioned that of Le Duchat (1711); the Variorum edition (1823–26); a splendid edition, illustrated by Gustave Doré (1858); a one-volume edition by Louis Barré (1864). Four volumes of a fine edition of his complete works, with notes and a glossary by Marty-Laveaux, appeared at Paris in 1868–81. There are English translations by Urquhart and Motteux (1653–94; new edition 1892), and W. F. Smith (1893). Consult: Besant, ‹Rabelais› (1879); Besant, ‹Readings in Rabelais› (1881); Stapfer, ‹Rabelais, sa Personne, son Génie, son Œuvre› (1889); Gebhart, ‹Rabelais, la Renaissance et la Réforme› (1895).

Rabies. See HYDROPHOBIA.

Rabshakeh, răb-shăk'ĕ, an officer of the king of Assyria, mistaken in the Authorized Version of the Bible for a proper name, but in fact an official title, probably that of a military commander. He is sent with Tartan and Rabsaris, also titles of high officials, to take a threatening message from Sennacherib to King Hezekiah. He delivers it in the Hebrew tongue, and when requested to use the Aramaic dialect, the language of diplomacy, so as not to alarm the people, he insolently refuses. (2 Kings xviii.–xix.; Isaiah xxxvi.–xxxvii.)

Raccoon′, the name, of Indian derivation, given to the typical members of the *Procyonidæ,* a family of carnivorous mammals, resembling the bears in their plantigrade feet and other characters, but differing from them especially in the long tail, sharp snout, slender body, and moderate size. All of the five or six known genera are confined to America, though the related Asiatic genus *Ælurus* is now placed here. (See PANDA.) The members of the typical genus *Pracyon* possess six incisors, two canines, eight premolars, and four molars in each jaw, and the group is well exemplified in the common raccoon (*Procyon lotor*) which derives its specific name of *lotor,* «a washer,» from its habit of washing its prey before eating it, or of holding the food in the fore paws and shaking it violently backward and forward in the water so as to moisten and saturate it as thoroughly as possible. The raccoon is a heavily built animal, about three feet long, with a pointed snout, short ears and bushy tail alternately ringed with black and white. The general body color is a sooty or blackish-gray, and the fur consists of a close set of under hairs, with larger outer hairs, the latter being marked black and white. The upper part of the head and the portion across the eyes are colored dark brown. Throughout most of the United States the raccoon is abundant, and on the Pacific side reaches from Alaska to Central America. In spite of the settlement of the country and much persecution it generally holds its own, and in many sections is actually increasing in numbers. These animals, although typically carnivorous, yet seem to feed largely upon, and indeed to prefer, vegetable matters. In the natural state their food consists of all kinds of small birds and their eggs, mice, reptiles, frogs, crayfish, mussels, oysters, nuts, fruits, etc. Occasionally they catch fish or clear out a hen roost, and their frequent depredations upon fields of corn, of which they are very fond in the milk stage, has gained them the enmity of farmers. They are, as already remarked, fond of moisture and water. The German name, *Waschbär,* or «washing-bear,» is given to the raccoon for the same reason as that indicated by the specific name *lotor.* Raccoons are among the most strictly nocturnal of American mammals, and spend the day in sleep, usually in a hollow limb or tree trunk. During the winter they pass into an intermittent state of hibernation. About April four to six young are born, which remain with the parents for a year or more, forming the small parties in which these animals are usually found. The raccoons are much hunted by means of dogs, which force the animal to take refugee in a tree, whence it is dislodged by climbing. The subtlety and cunning displayed by these animals in their endeavors to escape have become quite proverbial — expressions such as «sly 'coon,» «wake as a 'coon,» indicating these qualities. They are, however, very easily trapped, and when taken young make very gentle and interesting pets. They use their fore paws almost as expertly as a monkey its hands, and their great curiosity prompts them to investigate everything which attracts their attention. The agouara or crab-eating raccoon (*P. cancrivorus*) is found throughout South America. It is generally larger than the common species, the tail being shorter, of a grayish-yellow tint, and marked with six black rings. The fur is blackish-gray, tinted with yellow, and of variable lights and shades over the different regions of the body. The eyes are surrounded by dark-brown patches, which run into the ears, and terminate in a patch on the top of the head. Although denominated «crab-eating,» it does not appear to be specially addicted to this dietary.

Related genera are *Bassaris,* of which *B. astuta* extends from Mexico into the southwestern United States, *Nasua,* the curious arboreal coatis of Mexico and South America, and *Cercoleptes;* represented by the Central and South American kinkajou, which has a long protractile tongue. Consult: Stone and Cram, ‹American Animals› (New York, 1902); and Beddard, ‹Mammals› (London, 1902).

Raccoon-dog, a small wild dog-like animal (*Nyctereutes procyonides*) of eastern China and Japan, much resembling a miniature raccoon in appearance, especially about the head. It lives in burrows, gathers most of its food (fish, crabs, etc.) along the banks of rivers, and is frequently kept in captivity, especially among the Japanese, who also value its fur and eat its flesh. Its fur is long and grizzled, but handsome; its muzzle sharp, ears short, and tail short and bushy. Consult Mivart, ‹Dogs, Jackals, Wolves, and Foxes› (1890).

Raccoon-oyster, a name in the Southern States for the small irregular wild oysters, growing numerously in the salt marshes, and much eaten by raccoons and other animals.

Race, Cape. See CAPE RACE.

Raceme, ra-sēm′, in botany, a form of infloresence in which the primary axis is elongated, and bears flowers placed on pedicels of nearly equal length, as in the currant. A raceme differs from a spike only in the flowers being stalked, instead of being sessile. See FLOWER.

Racer, or Blue Racer, a blacksnake (q.v.) especially the common lowland one (*Zemenis constrictor*), so called from its swiftness.

Rachel, in Bible history, the second daughter of the Aramaic cattle-owner, Laban. Jacob obtained her as wife by devoting 14 years to the service of her father. At the end of the first seven years he found in his veiled bride not the Rachel promised, but Leah, her elder sister, whom he did not love, and was obliged to serve seven years more in order to gain Rachel. She was the mother of Joseph and Benjamin. Her so-called tomb stands to this day on the road between Jerusalem and Bethlehem and is held in the highest veneration by both Jews and Mohammedans.

Rachel, rä-shĕl (ELISA RACHEL FÉLIX), French tragédienne: b. Munf, Canton of Aargau, Switzerland, 24 March 1821; d. Le Cannet, Provence 3 Jan. 1858. Her father was a German Jew, naturalized in France, and after much wandering about Europe established his family at Lyons, where the two oldest children, Sarah and Rachel, sang and begged in the street to help out the family support. About 1830 they removed to Paris and the two girls sang on the Boulevards until discovered by Etienne Choron, teacher in the School of Sacred Music, who undertook to teach them singing. Rachel's voice was found to be too harsh for this, and in 1834 Choron induced his friend, Pagnon Saint Aulaire, to train her for the stage. On the advice of M. Sanson she entered the Conservatoire, where, however, her harsh voice and small stature seemed at first against her. She made her debut in a play called 'La Vendéene' at the Gymnase, 1 May 1837. The next year she joined the company of the Theatre Français and made her first appearance as Camille in Corneille's 'Les Horaces' 12 June 1838. She appeared in several parts successively and finally repeated in September her performance of Camille, was seen and applauded by the powerful critic of the «Debats,» Jules Janin, and her position established. After appearing in other parts in the French classic drama with increasing success, she visited England in 1841 and again in 1842, repeating her triumphs there. Later while still supreme at the Theatre Français she made visits to other European cities, and in 1855 appeared in America. Here her success was only moderate, owing to her unfamiliarity with the language. A severe cold caught during her American tour ended in a consumption, from which she died at Le Cannet in the south of France. Her great reputation was made in five or six rôles of the ancient classic drama of France, of these Phèdre being accounted her greatest. In the course of her career she created 13 modern roles, written for her, 'Adrienne Lecouvreur,' alone of these still holding a place on the modern stage. She appeared in several other modern rôles that had been acted before her representation. Consult: Memoirs by Madame De B—— (1858); Janin, 'Rachel et la Tragedie' (1858); Kennard, 'Rachel' (1888).

Rachi'tis. See RICKETS.

Racine, Jean Baptiste, zhŏṅ bä-tēst rä-sēn, French dramatist: b. La Ferté-Milon, Picardy, 21 Dec. 1639; d. Paris 21 April 1699. He studied at the College of Beauvais, and subsequently at the Port-Royal Institution, where, under the care of Lancelot and Lemaistre, he became a profound Greek scholar. In 1658 he left the Port-Royal, and began the study of philosophy at the Collège d'Harcourt. To this period belong his first literary efforts, an ode called 'Nymphes de la Seine,' composed in honor of the king's marriage, and for which he was rewarded by Chapelain, then the dispenser of the royal bounty; and two comedies, now lost. About the same time he became intimate with La Fontaine, and this intimacy was so far from tending to make his life more regular, that those of his relations who took most interest in him, and who had destined him for the church, began to be anxious about his prospects. In 1661 he went to live with an uncle, a canon-regular and vicar-general of the cathedral at Uzès (department of Gard), whose influence it was expected would suffice for procuring him a benefice. In this last particular they were disappointed; and at the end of about two years, during which Racine had been vainly endeavoring to study theology, he returned to Paris and the world. In 1663 he was presented at court, and soon made the acquaintance of Boileau and Molière, and began to write for the stage. His first tragedy, the 'Thébaïde,' or 'Les Frères Ennemis,' was first performed by Molière's troupe at the Palais-Royal in 1664, as was also his next, 'Alexandre,' in 1665. But his devotion to the drama did not deprive him of all chance of ecclesiastical preferment, for in 1667 he received the priory of Espinay, and afterward the livings of Saint-Jacques de la Ferté and Saint-Nicolas de Chésy. The drama, however, continued for many years to be his sole serious occupation. His first two tragedies were merely tentative pieces, containing but few indications of the author's dramatic genius. His first master-piece was 'Andromaque,' which on its performance in 1667 produced a profound impression and excited well-merited admiration. It was brought out at the Hôtel de Bourgogne, Racine having in the meantime quarreled with Molière. The immediate successor of 'Andromaque' was a comedy (Racine's only extant comedy), 'Les Plaideurs,' a witty and delightful imitation of the 'Wasps' of Aristophanes. It appeared in 1668, and was at first rather coldly received, being indeed saved only by the laughter of the king. His next pieces were 'Britannicus' (1669); 'Bérénice' (1670), composed at the request of Henrietta of England, who had also invited Corneille to write a drama on the same subject; 'Bajazet' (1672); 'Mithridate' (1673); 'Iphigénie' (1674), considered by Voltaire the greatest work that the French stage has produced; 'Phèdre' (1677), the last piece that Racine produced expressly for the theatre. Little is known of the private life of Racine during this period, almost all his correspondence having been burned from a too pious respect for his memory. In 1673 he obtained a seat in the French Academy. In 1675 he was nominated by Colbert a royal councillor and treasurer of France for the general government of Moulins (Bourbonnais), but never entered on the duties of his office. His withdrawal from the theatre in 1677 was partly due to chagrin at the success of a hostile party of theatrical critics who set up for being fine wits, and applauded one Pradon, a writer now never heard of, at the expense of Racine. Soon after (1678) he was appointed, along with Boileau, historiographer to the king, whom he accompanied in his campaign to

Flanders. After a silence of 12 years Racine, at the solicitation of Madame de Maintenon, added two other pieces to the list of his dramatic works — 'Esther' (1689) and 'Athalie' (1691), the latter often spoken of by French critics as the most perfect of his works. They were both intended for the pupils of Saint-Cyr, the institution founded by Madame de Maintenon. The death of Racine is said to have been hastened by grief at losing the favor of the king. As a dramatist Racine is usually considered the model of the classical or national tragic drama of the French, and in estimating his powers in this field it is necessary for the critic to take into account the stiff conventional restraints to which that drama is subjected. What Racine achieved within these limits is extraordinary. He added to the conventional drama as he received it a grace of which one would not have deemed it capable; he was greater as a poet than as a dramaturgist, and wrote in a style of finished perfection and distinction, developing French versification to its ultimate of rhythm and dignity. In his restraint, proportion, balance, he is rightly regarded as classic. «Perhaps it would be no exaggeration to assert,» says Dowden, «that grandeur and beauty are nowhere else so united in French dramatic art as in 'Athalie.' » Besides his dramas Racine wrote several stinging epigrams, some odes and hymns, an abridgment of the history of Port-Royal, letters, and historical fragments on the campaigns of Louis XIV. Among his letters are two in reply to a work of Nicole of the Port-Royal, entitled 'Les-Visionnaires' (1666), in which the author bitterly denounces poets and still more dramatic writers. The tone of these letters is severely sarcastic, and naturally caused great offense to his old friends and masters. Only one of the letters was published at the time they were written, the other after his death. After his retirement from the theatre Racine found it easy to reconcile himself with his old friends. Among the editions of the 'Œuvres Poétiques' of Racine, one of the best is that published at Paris in three volumes (1801-5), regarded as a marvel of typography. An excellent edition of 'Œuvres Complètes' was published in 1865-73 in Hachette's collection of the 'Grand Ecrivains de la France,' preceded by an admirable essay on Racine and his time by Paul Mesnard. There is an English metrical translation by R. B. Boswell (1889-91). Consult also the study by Monceaux (1892, in the 'Collection des Classiques Populaires'); Stendhal, 'Racine et Victor Hugo' (1887); Sainte Beuve, 'Port Royal' (4th ed. 1878).

Racine, Louis, French poet and critic, son of Jean Racine (q.v.): b. Paris, France, 2 Nov. 1692; d. there 29 Jan. 1763. He attained considerable attention as a poet and critic though manifestly under a disadvantage as the son of so eminent a father. His poems 'La Grâce' (1720) and 'La Religion' (1742) were highly praised and the latter ran through 60 editions. He wrote in prose: 'Reflections upon Poetry'; 'Memoirs of the Life of Racine'; and 'Remarks on Racine's Tragedies.' His complete works were published in 1808.

Racine, Wis., city, county-seat of Racine County; on Lake Michigan at the mouth of Root River, and on the Chicago, M. & St. P., and the Chicago & N. W. R.R.'s; about 22 miles south of Milwaukee and 65 miles north of Chicago. It has steamboat connections with all the lake ports, and electric lines extend to all the nearby towns. It is 40 feet above the surface of the lake, and 690 feet above sea-level. It was settled in 1834; in 1843 was incorporated as a village, and in 1848 was chartered as a city. Racine has a good harbor, one of the best on the lake. It is the commercial and industrial centre of a productive agricultural region about midway between Milwaukee and Kenosha. The chief manufacturing establishments are knitting mills, machine shops, flour and lumber mills, carriage factories, foundries, boot and shoe factories, tanneries, valise and trunk factories, steel spring works, hosiery mills, furniture factories, breweries, plating works, and woolen mills. The products from other manufactories are, bedding, men's clothing, paints, mangles, fanning mills, windmills, bicycles, bits, sheet iron, brass and copper goods, iron specialties, malted milk, chemicals, soap, and other articles. The manufacturing interests are increasing; it is (1904) the second city in the State in the value of its manufactures. In 1903 the capital invested in manufactories was nearly $18,000,000; and the value of the output was over $14,000,000. The prominent public buildings and institutions are, the government building, which cost originally $100,000, the county court-house, the municipal buildings, Saint Luke's Hospital, Saint Mary's Hospital, Taylor Orphan Asylum, and the Dominican convent. The educational institutions are Racine College (P.E.), founded in 1852, the Racine Grammar School (P.E.), Saint Catharine's Academy (R.C.), a public high school, public and parish schools, a public library, which contains about 9,000 volumes, two libraries connected with Racine College, and the Y. M. C. A. library.

The government is administered under a revised charter of 1891, which provides for a mayor, who holds office two years, and a council. The mayor appoints, subject to the approval of the council, the members of the school board. Pop. (1910) 38,002.

Racing. See HORSE-RACING.

Rack, an instrument of torture in frequent use in the Middle Ages, and down to a comparatively recent period. It is not known to have been used in the American colonies settled under British rule, but it is among the ancient instruments of torture preserved at Montreal as relics of French rule in that country. The rack consisted of a large, open, wooden frame, within which the person to be tortured was laid on his back on the floor, with his wrists and ankles fastened by cords to two rollers at the ends of the frame. These rollers were then drawn or moved in opposite directions till the body rose to a level with the frame. Interrogations were then put, and if the prisoner refused to answer, or if his answers were not considered satisfactory, the rollers were further moved, until at last the bones of the sufferer were forced from their sockets. The rack was also used simply for purposes of punishment, apart from desire to extort a confession.

Rackets, or **Racquets,** a game played in a prepared court, open or close, with a small hard ball and a kind of bat. The bat is about two feet in length, about two thirds of which forms the shaft or handle, the remainder being an oval frame on which is tightly stretched a net-work of cat-gut. The part of the shaft by which the bat is held is covered with leather and ribbed, to enable the player to grasp it firmly. It is from this bat and the net-work, which is its principal feature, that the game derives its name (Italian, *racchetta,* for *retichetta,* an old diminutive of *rete,* Latin and Italian, a net; French, *raquette*). The close, that is, roofed court, is now generally preferred for playing in. It is an oblong rectangular space, and when of full dimensions is 80 feet long, 40 feet broad, and has walls 40 feet high. The players stand facing one of the narrow walls, which is called the front wall. Two horizontal lines are drawn across the front wall, one two feet two inches, and the other, the out or service line, eight feet above the floor. The surface between the floor and the lower of these lines is covered with wood, which serves as a sounding-board to enable the players to know when it is struck by the ball.

The game may be played either single or double, that is, with either one or two persons on each side. It is decided by lot which side goes in first, and when there is only one player on each side the first player assumes which side of the court he pleases (usually the right), while the other stands in the opposite corner. The first player then begins to *serve,* in doing which he must have one foot in the service box of his side. Service consists in striking the ball with the bat so as to make it strike the front wall above the out line without previously striking any other part of the court, and then rebound into the opposite corner beyond the short line. In rebounding from the front wall it does not matter whether the ball strikes either of the side walls or not before it lights on the floor in the opposite corner of the court. If the ball is properly served the second player must strike it before it has made a second bound, so that it strikes the front wall above the board; but in returning the ball in this manner the player may if he likes first make it strike either of the side walls. The player to whom a ball is served does not require to wait till the ball has bounded from the floor before he returns it. He may if he likes return it before it touches the floor. Such a stroke is called a volley. The ball being thus returned by the second player, the first player returns the ball in the same way, and this goes on until either player fails, which may happen in three ways, either by the ball being made to hit the sounding-board, or being struck into the roof or gallery, or later than the first bound. If it is the first player who fails, his hand is out, and it is then the turn of the second player to serve. If it is the second player, then the first scores one (an ace), and the first continues to serve, but goes to the opposite side of the court. The other details of the game must be derived from the rules drawn up by the different racket clubs.

Raco'vian Catechism, the catechism of Rakow, Russia, where it was originally printed and published. It contained a popular exposition of Socinianism. There were two such catechisms, a smaller and a larger, both afterward published in Germany by Smalcius, the former in 1605, the latter in 1608. In 1652 John Biddle translated the larger of the two into English.

Radcliffe, răd'klĭf, **Ann Ward,** English novelist: b. London 9 July 1764; d. there 7 Feb. 1823. She was married at 23 to William Radcliffe, afterward editor and proprietor of the weekly called 'The English Chronicle.' Her first work was 'The Castles of Athlin and Dunbayne,' a Highland story (1789). It had little success, but perhaps as much as it deserved. 'A Sicilian Romance' (1790) is superior to it, and 'The Romance of the Forest' (1791), a still further advance, was dramatized and translated into French and Italian. Her master-piece is considered to be 'The Mysteries of Udolpho' (1794), which was long very popular. The last of her novels published during her life was 'The Italian' (1797), dramatized as 'The Italian Monk,' and translated into French by Morellet. A posthumous romance, 'Gaston de Blondeville,' was edited by T. N. Talfourd in 1826, together with some poems. Another work of hers was 'A Journey through Holland and Germany' (1795). Mrs. Radcliffe's novels were at one time very popular. She had considerable power in the description of scenery, and well understood how to excite and maintain the curiosity of her readers. She was perfect mistress of the mysterious in romance and the first English writer of note to introduce descriptions of scenery into fiction. Consult: Beers, 'English Romanticism' (1898).

Radcliffe, John, English physician: b. Wakefield, 1650; d. London 1 Nov. 1714. He was educated at Oxford and there began the practice of medicine, but removing to London in 1684 soon established a large practice which he maintained, it is said, more by his witty conversation than his medical skill. In 1686 he became physician to the Princess Anne of Denmark, and frequently attended William III., after his succession. His bluntness of speech lost to him the favor of Princess Anne and later of King William, though he continued to number many of the nobility among his patients and prescribed for Pope and Swift. His learning was often depreciated; but he seems to have been an acute observer of symptoms and his immense practice gave him a wide field for observation. By his will property was left in trust for the foundation of two medical fellowships, and for the purchase of perpetual advowsons for members of University College. He also left money for the erection of various public buildings, among which was £40,000 for the public library in Oxford, since called the Radcliffe Library. From estates left in trust to the executors to administer for charitable purposes according to their judgment were built the Radcliffe Infirmary, the Observatory at Oxford, and enlargements to St. Bartholomew's Hospital. Later money was granted toward the buildings of the College of Physicians in London, the Oxford Lunatic Asylum and St. John's Church, Wakefield.

Radcliffe, England, in the county of Lancashire, seven miles northwest of Manchester, on the River Irwell. The ancient parish church of St. Bartholomew dates from the time of Henry IV. There are cotton and calico works, bleach-fields, and extensive collieries in the vicinity.

Radcliffe College, a college for the education of women, affiliated with Harvard University, Cambridge, Mass. Its forerunner was the

Society for the Collegiate Instruction of Women, organized in 1879 to provide systematic instruction for women by professors and instructors in Harvard. This Society was incorporated three years after its organization, and its educational work proved so successful that in 1894 it was formally affiliated with the University. At that time the name of the Society was changed to Radcliffe College, power to grant degrees was conferred, and the president and fellows of Harvard University were constituted the board of visitors of Radcliffe, which should have supervision over the administration of the affairs of the college, the granting of degrees, the appointment of instructors, etc. All diplomas given by Radcliffe are countersigned by the president of Harvard and bear the University seal. Most of the courses of study are identical with the Harvard courses, and graduate students are admitted to some of the graduate courses of the University. The courses are divided into three groups in the different branches of study: (1) courses primarily for undergraduates; (2) courses for graduates and undergraduates; (3) courses primarily for graduates. Courses in Semitic languages and history, history and theory of education, pedagogy, and the history and theory of art and music, are included in the curriculum. The degrees of A.B. and A.M. are conferred. There are two fellowships, one for the promotion of the study of Greek history, literature, art and archæology of the American School at Athens, and one for the promotion of the study of social problems at a settlement house in Boston; there are also eleven scholarships. The college has laboratories of physics, chemistry, zoology, and botany,— the library numbered 26,000 volumes in 1910; the University library and museums are also opened to students of Radcliffe; in 1904 a new hall fully equipped with auditorium, club rooms, etc., was built. The students in 1910 numbered 485 and the faculty 104. Le Baron Russell Briggs of Harvard University was appointed president in 1903.

Radecke, rā'dĕ-kė, **Robert,** German composer: b. Dittmannsdorf, Silesia, 31 Oct. 1830. He was educated at the Conservatory of Leipsic and in 1853 became musical director of the Stadt Theatre of Leipsic. He afterward served for a year in the army and then settled in Berlin where he engaged as second violin in Laub's quartet and in 1858–63 conducted choral and orchestral concerts with much success. In 1863 he was appointed musical director of the Royal Opera and in 1871 was made royal Kapellmeister for life. He was the successor of Haupt as director of the Royal Institute for Church Music in 1891. Radecke excels as a performer on pianoforte, organ, and violin, but his greatest talent is shown in his compositions, which include about 100 songs, the operetta 'Die Mönkgüter'; overtures, 'König Johann'; 'Am Strande'; etc.

Radegun'da, Saint, Frankish queen: b. Thuringia, Germany, 510; d. Tours, France, 13 Aug. 587. She was the daughter of the heathen Berthar, king of the Thuringians, and was carried off prisoner when a child after the victory of Clothaire, king of the Franks, over her father. She was eventually converted to Christianity and married to Clothaire (538). In 553 she took the veil, founded the monastery of Sainte Croix at Tours, and made her dwelling there. Her life was written by her contemporary and friend, the famous poet, scholar and bishop, Venantius Fortunatus (q.v.). Consult: Bussierre, 'Histoire de Sainte Radegonde' (1864).

Radetzky, rā-dĕt'skē, **Johann Joseph Wenzel Anton Fritz Karl,** COUNT, Austrian military officer: b. Trebnitz, Bohemia, 2 Jan. 1766; d. Milan, Italy, 5 Jan. 1858. He joined the Austrian army in 1784, served in the campaigns against the Turks in 1788–9, in 1809 became lieutenant field-marshal and served with ability at Aspern and Wagram. After the peace of Schönbrunn he was appointed a member of the state council of war. In the war with France he fought at Kulm and Leipsic in 1815, and in 1831 was made commander of the Austrian troops in Italy. He was created field-marshal in 1836 and in 1848–9 he crushed the revolution in Venice and Milan. He preserved Lombardy to Austria, routed the army of the Piedmontese at Custozza and Novara in 1849, concluded a treaty which assured Austrian supremacy in Italy for the time, and governed the Austrian possessions there until 1858 when he resigned. Consult: Troubetskoi, 'Campagnes du Comte Radetsky dans le Nord de l'Italie en 1848 et 1849' (1860); Kunz, 'Die Feldzüge des Feldmarschalls Radetsky in Oberitalien' (1890).

Rad'ford, William, American naval officer: b. Fincastle, Va., 1 March 1808; d. Washington, D. C., 8 Jan. 1890. He entered the navy in 1825, served in the war with Mexico, and performed gallant service at Mazatlan. When the Civil War broke out he was assigned to the Cumberland; was promoted captain in July 1862, and commodore in April 1863. During the assaults on Fort Fisher, in 1864–5, he commanded the New Ironsides and the ironclad portion of Porter's fleet. He was promoted to rear-admiral in July 1866, was in charge of the European squadron in 1869 and was afterward on duty in Washington until he was retired in March 1870.

Radhanpur, răd-han-poor', India, (1) chief town of a state in the Bombay presidency surrounded by a wall which encloses a fortified castle and the residence of the native prince. A fine sort of saltpeter is manufactured and there is some trade in cotton, wheat and grain. Pop. 14,722. (2) The state of Radhanpur in the northwest of Gujerat, covers an area of 1,150 square miles. Pop. 98,129.

Ra'dian. See MECHANICS.

Radiant Star, Order of the. See ORDERS (ROYAL) AND DECORATIONS.

Radia'ta, one of the great divisions of the animal kingdom in the classification of Cuvier, characterized by having the parts of the body arranged around a vertical axis like the spokes around the hub of a wheel. Later, it was shown by Leuckart that the group was unnatural, and it has been discarded for many years. Its chief numbers are now included in the *Cœlenterata* and *Echinodermata* (q.v.). As limited by Cuvier it also embraced some of the *Protozoa*, the *Polyzoa*, some parasitic worms, and a few other forms.

Radiation. By radiation is meant the propagation of energy in straight lines from a radiant point. This radiation is in the form of vibrations connected with an ether which fills all space, both molecular and stellar. Such energy is best known as radiant heat, and when the vibrations are of sufficient rapidity to excite the nerves of vision, it is called light. Such a conception presupposes the origin of the radiations to be the oscillations of the ultimate particles of matter. The mode of propagation is a wave motion, to and fro, across the line of radiation. In sharp distinction from this was the material theory of heat, held by some physicists previous to the investigations of Balfour Stewart, by which «caloric» or heat was regarded as «imponderable matter» stored up, or driven from bodies by chemical or mechanical means. Strange to say, the latest discoveries in radiation, point back to this long discarded theory.

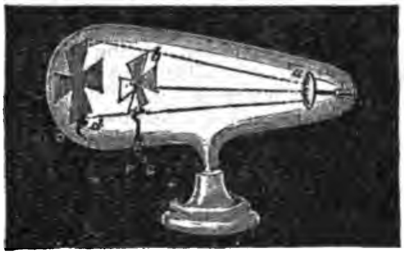


Fig. 1.—The radiant energy from *a* traveling in straight lines is intercepted by the aluminum cross *b*, which casts its shadow at *d*.

Radiations of Heat and Light.— Physical science, at the opening of the 20th century, had established the mutual relationships of heat and light. (1) Both had been found to be propagated in straight lines, with a speed approximately of 186,000 miles per second. (2) The laws of reflection and refraction were the same in each. (3) The intensity of radiant heat, and that of light, varied inversely as the square of the distance. (4) Synchronism of vibration, interference of wave motion, and polarization were the same in each. (5) They were alike subject to selective absorption, and absorption was equivalent to radiation.

By means of the ***spectrum***, the wave-lengths and frequency of vibration corresponding to different degrees of radiant heat, light, and actinic power had been ascertained. For instance, we know that, beginning at the lowest radiant heat measurable, we have in the neighborhood of 12,500,000,000 vibrations per second, and 944 millionths of an inch as the length of the wave. As the vibrations become more rapid and the length of the wave shorter, radiant heat becomes luminous and is known as light.

Vibrations and Wave-lengths.— With a vibration period of about 344,000,000,000 per second, and a wave-length of 32 millionths of an inch, particles of matter assume a dull red color. From this point on they pass successively through the colors of the spectrum — namely, red, orange, yellow, green, blue, indigo, and violet, until the eye, by reason of its physical limitations, ceases to take cognizance of them. At about 700,000,000,000 vibrations per second and a wave-length of 16 millionths of an inch, they are known as actinic or ultra-violet rays. The photographic plate responds to these rays up to 1,485,000,000,000 vibrations per second, with a wave-length of 7.95 millionths of an inch, and they will produce fluorescence up to a period of 1,621,000,000,000 vibrations, with a wave-length of 7.28 millionths of an inch. Scientific investigation is now largely confined to these ***higher radiations***. As a starting point, we begin with investigations of Professor William Crookes, who discovered in 1879 that the highly attenuated matter in a vacuum tube, through which the discharge of an induction coil is passing, becomes luminous as the exhaustion of the tube increases. While Crookes' theory of a fourth state of matter, known as «radiant matter,» has not been wholly approved or disapproved, it remains as the basis of modern discoveries in radiation. In all highly exhausted vacuum tubes, a small dark space surrounds the negative electrode during the electric discharge.

Radiations in Vacuum Tubes.— Crookes found that the dark space increases in length as exhaustion proceeds.

The explanation, according to Professor Crookes, is that the molecules of attenuated matter travel over comparatively long spaces before coming into contact with other molecules, which by their collision produce light.

The radiant energy within the tube travels in straight lines. Shadows are cast by intercepting objects, as in the case of light. (See Fig. 1.) Mechanical motion can be produced by directing the radiant energy against a light wheel. (See Fig. 2.) Crookes' radiometer, a familiar piece of apparatus seen in opticians' windows, operates on this principle and that of re-action. Significant discoveries in this connection followed: first, that the stream of radiant energy could be deflected by a magnet; second, that two streams of radiant energy repelled each other, after the manner of matter similarly electrified: third, that the stream of radiant energy, when focused upon a metal, such as irido-platinum, heated it white hot. Glass also cracked and softened under its impact.

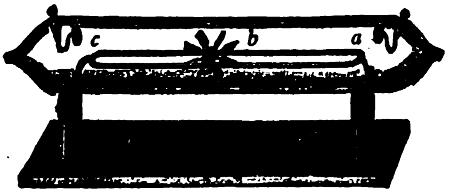


Fig. 2.—The stream of radiant matter from *a* strikes the upper vanes of the little paddle-wheel *b*, and causes it to roll along the rails. If the tube is inclined, the force is sufficient to drive the wheel up hill.

In 1894, Lenard, acting on a hint from Hertz, constructed a window of thin aluminum connected with the positive pole in Crookes' vacuum tube, and found that a faint bluish glow extended through the window into the air outside, and vanished at about two inches from the window. In this glow, uranium glass, calc spar, and a few other substances became phosphorescent. The radiations passed through screens of gold leaf, silver or aluminum easily. Electrically charged bodies were found to be discharged in the glow outside of the window and even beyond its visible limits.

Roentgen or «X-rays.»— In 1895 Prof. Roentgen, of the University of Würzburg, discovered that a Crookes' tube covered with black cardboard emitted rays which penetrated the glass and cardboard. He immediately investigated their origin with a vacuum tube similar to Lenard's, but with a glass instead of an aluminum window, and found the source of these unknown rays in *the window itself*, where the impact of the radiation inside of the tube took place. He found that these unknown or «X-rays» were not the same as the radiation inside of the tube. The latter were deflected by a magnet, the «X-rays» were not.

The «X-rays» penetrated glass, tin, aluminum, or, generally speaking, metals of low atomic weight, while the radiant energy inside the tube possessed no such penetrating power. The «X-rays,» however, will produce fluorescence — chemical action, and discharge electrified bodies — the same as ultra-violet rays. *They are not refracted, nor reflected, nor subject to diffraction, like light, and Prof. Alfred M. Mayer, of this country, has shown that they are incapable of polarization.* These latter facts regarding diffraction and polarization, as well as the non-interference of «X-rays,» go to prove that they cannot be propagated according to the laws of wave motion, hence the theory of radiant energy assumed at the beginning of this article finds here an exception. In the case of the radiant energy within the vacuum tube, it seems evident that the phenomena are the result of streams of electrified particles of residual matter, shot off from the cathode in straight lines perpendicular to its surface. These flying particles falling upon anything in their path will give rise to «X-rays.» The most important applications of the «X-rays» have been in the fields of anatomy, surgery, and diagnosis, where, owing to their ability to penetrate animal tissues, they have been extensively used to locate foreign bodies, and for the examination of dislocated bones and abnormal growths.

In 1896 M. Henri Becquerel discovered the presence of invisible radiations proceeding from the salts of uranium, and later from uranium itself — which radiations penetrated aluminum and produced shadow pictures somewhat after the manner of «X-rays.» These radiations were proved to have their source within the substance of the uranium itself. This brings the subject of radiation down to the remarkable properties of radium, discovered by M. and Mme. Curie, of Paris, in 1898. See RADIUM.

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Radiation of Heat. See HEAT.

Rad'ical, the name adopted by a large section of the Liberal party in Britain, which desires to have all abuses in the government completely rooted out, and a larger portion of the democratic spirit infused into the constitution. The immediate aim of Radicals at different times has necessarily varied considerably; and though the party is now identified almost exclusively with political reform, the Radicals of the past achieved their greatest success in compelling attention to important economic changes tending to improve the condition of the laboring population. The term is applied in general usage to persons of extreme views in connection with so-called political and social reforms.

Radical, or **Radicle,** in chemistry (and particularly in organic chemistry), a name given to certain molecular groups whose constituent atoms possess such relations and affinities that the groups themselves persist and maintain their integrity, even when the compounds in which they occur undergo profound chemical change. The following example will illustrate the nature of a radical more clearly: Ordinary alcohol (ethyl alcohol), when free from water, has the chemical formula C_2H_6O. If this be saturated with hydrochloric acid gas in the presence of chloride of zinc, a compound having the formula C_2H_5Cl is formed; and by treating the alcohol with iodine under proper conditions, an analogous compound having the formula C_2H_5I is obtained. When this last substance is heated with water and metallic zinc, we obtain the hydrocarbon gas ethane, C_2H_6. These reactions, and others of a similar nature, suggest that the molecular group C_2H_5 persists through all of these changes; and this hypothesis is found to be justified in every way. The group C_2H_5 is therefore a «radical,» and to it the name «ethyl» has been given. The gas ethane, C_2H_6, is the hydride of ethyl, according to this view, and its formula may be written $C_2H_5.H$. Similarly, C_2H_5Cl and C_2H_5I are known, respectively, as ethyl chloride and ethyl iodide. Ethyl alcohol, in the same way, is regarded as the hydrate of the radical ethyl, and its formula is written $C_2H_5.OH$. Ethyl is thus seen to be a monovalent radical with a high degree of stability, behaving, in its chemical relations, very much like the alkali metals, potassium and sodium. Many compounds are known in which two or more molecules of ethyl occur, with their combined valencies satisfying a single divalent atom or radical. Ordinary ether, for example, is the oxid of ethyl, its formula being $(C_2H_5)_2O$. The analogy of this substance with the oxid of potassium, K_2O, is complete.

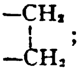
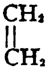
If the persistence of a radical were absolute, so that we could never destroy the radical by any chemical or physical means, we obviously could not distinguish it from an element: and it is quite possible that some of the bodies that we now recognize as elements are merely radicals of extraordinary persistence, but which we may some day succeed in breaking up into their constituents. This is pure speculation, however, and until we know more about the ultimate constitution of matter, we are to regard a «radical» merely as a convenient conception, which enables us to simplify chemical formulæ, and to form a clear general view of the analogies and chemical relations that subsist among various chemical compounds. Radicals may be classed as «acid» or «basic,» according as they have an acid or a basic character. Thus the radical SO_4, which occurs in sulphuric acid and in the sulphates, and which is called «sulphion,» is an acid radical, while ethyl, C_2H_5, is basic.

Among the simpler inorganic radicals that are of frequent occurrence, the following are monovalent: Hydroxyl (OH), the «nitro» group (NO_2), the «nitroso» group (NO), the «amido» group (NH_2), and cyanogen (CN). The following are divalent: Sulphion (SO_4), sulphuryl (SO_2), the «imido» group (NH), and the «thionyl» group (SO). In organic chemistry many radicals are recognized. The commoner basic radicals of the fatty series may be regarded as derived from the saturated hydrocarbons (or paraffins) by the removal of one or more atoms of hydrogen. Thus we have the following series, which are derived in the manner described, the radicals in each column being obtained from the paraffin at the head of that column by the removal of hydrogen atoms:

CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}
Methane	Ethane	Propane	Butane	Pentane
CH_3	C_2H_5	C_3H_7	C_4H_9	C_5H_{11}
Methyl	Ethyl	Propyl	Butyl	Pentyl
CH_2	C_2H_4	C_3H_6	C_4H_8	C_5H_{10}
Methylene	Ethylene	Propylene	Butylene	Pentylene
CH	C_2H_3	C_3H_5	C_4H_7	C_5H_9
Methenyl	Ethenyl	Propenyl	Butenyl	Pentenyl
C	C_2H_2	C_3H_4	C_4H_6	C_5H_8
(Carbon)	Ethine	Propine	Butine	Pentine

The names here assigned to the radicals are due to Hofmann, and the system in accordance with which they are formed will be sufficiently evident, without further explanation. Hofmann's names are now commonly adopted, but some of the foregoing radicals are still known by other names also. Thus Hofmann's «ethenyl» is often called «vinyl»; and, similarly, his «propenyl,» «butenyl,» «ethine,» «propine,» and «butine» are respectively known as «glyceryl,» «crotyl,» «acetylene,» «allylene,» and «crotonylene.»

The radicals tabulated above, and which are of constant occurrence in organic chemistry, contain only hydrogen and oxygen. Many organic radicals are known, however, which contain other elements also. The first oxygen-bearing group to be recognized as a radical was «benzoyl,» C_6H_5CO, which occurs in benzoic acid, and in many other compounds that are related to the oil of bitter almonds. This radical was recognized by Liebig and Wöhler, in 1832. Many such radicals are now recognized, especially in the organic acids and their derivatives. As an example, «acetyl» may be cited. This has the composition C_2H_3O, and acetic acid, $C_2H_3O.OH$, is its hydrate.

Many of the radicals are not capable of independent existence, and hence cannot be isolated. Others may be obtained in the free state, or in the form of a compound in which two similar radical groups are united to each other. When methyl iodide is heated with metallic zinc, the iodine is taken up by the zinc, and the methyl radical, CH_3, is liberated. It is not obtained in the form of methyl, however, for at the moment of its liberation two of the radicals combine to form a molecule of ethane, C_2H_6. Ethane, therefore, may be regarded as «di-methyl,» having the formula $CH_3 — CH_3$, or as «ethyl hydride,» having the formula $C_2H_5.H$. It is convenient to regard it from one of these points of view for some purposes, and from the other for other purposes. A radical of the series tabulated above can exist in the free state, save for a slight change in its internal linkage, provided its valency is an even number, and the free bonds belong to adjacent carbon atoms. Ethylene, for example, has the formula C_2H_4. When it exists as a radical, in combination with other atoms, it is divalent, and has the structure  $\begin{array}{l} -CH_2 \\ \;\; | \\ -CH_2 \end{array}$; the two carbon atoms being connected by one internal bond, while each carbon atom also has one bond which is satisfied by the external atoms with which the radical is combined. When the ethylene exists as a free hydrocarbon, the two free bonds shown in the foregoing rational formula satisfy each other, and the constitution of free ethylene therefore is  $\begin{array}{c} CH_2 \\ \| \\ CH_2 \end{array}$.

The idea of a compound radical is due to Lavoisier; and the conception, although its validity was earnestly disputed for some years, has been of great importance in the development of chemistry. The definition of a radical, as given by Liebig in 1838 in his discussion of cyanogen, holds good at the present day. He said: «We call cyanogen a radical because (1) it is the invariable constituent in a series of compounds; (2) because it can be replaced in these compounds by other simple bodies; (3) because in its compounds with a simple body the latter can be replaced by equivalents of other simple bodies.» At least two of these three characteristics must be fulfilled by a group of atoms, before that group can be regarded as a «radical.»

Consult Hjelt, 'General Organic Chemistry'; Meyer, 'Modern Theories of Chemistry.'

A. D. Risteen, Ph.D.,
Editorial Staff, 'Encyclopedia Americana.'

Radiguet, Maximilien René, French explorer: b. Landerneau, Finisterre, 17 Feb. 1816; d. 1892. He was educated in the School of Fine Arts at Paris, and in 1838 became secretary to Admiral Charles Baudin and Count de Las Casas, on a mission that had been sent to Haiti to negotiate with the government of that country for the payment of an indemnity to the descendants of the French citizens that had been murdered during the troubles of 1798–1803. His influence was of great value in bringing the negotiations to a speedy conclusion, several times preventing the impatient admiral from bombarding Cape Haytien. He was afterward secretary to Admiral Du Petit-Thouars, 1841–5, and traveled through South America and the Marquesas Islands, and afterward devoted himself to literary labors. Among other works he has published 'Souvenirs de l'Amérique Espagnole: Chile, Pérou, Brésil' (1856; revised ed. 1874).

Radioactivity. Although only a few years have elapsed since Becquerel (1896) discovered that uranium possessed the property of spontaneously and continuously emitting penetrating rays, capable of passing through bodies opaque to ordinary light, our knowledge of the subject of radioactivity has increased with great rapidity and a very large mass of experimental facts has now been accumulated. Only a very brief account of the remarkable properties possessed by the radioactive bodies is possible in this short article.

Shortly after the discovery of this property in uranium, Mme. Curie and Schmidt independently found that the heavy element thorium, which is used in the manufacture of Welsbach mantles, was also radioactive and to about the same degree as uranium. The latter substance is commercially obtained from the mineral pitchblende and in an examination of the radioactive properties of this mineral, Mme. Curie was led to the conclusion that other and more radioactive substances must be present in it. By an admirable piece of chemical research, Mme. and P. Curie succeeded in separating from it two new very active substances which were called radium and polonium. The substance radium was well named as, in the pure state, it gives out radiations about two million times as intense as uranium. Polonium has not yet been chemically isolated. It differs from radium in losing its activity with the time. Several years after separation, the activity has diminished gradually to a small fraction of its original value.

Another substance called radio-tellurium was separated from pitchblende by Marckwald. It has radioactive properties similar to polonium, and probably contains the same radioactive constituent. In addition to these bodies, Debierne and Giesel independently discovered another very active substance called actinium, while Hofmann found that lead separated from pitchblende was very active and called the radioactive substance present in it "radio-lead." With the exception of radium, none of these bodies have been chemically isolated. Actinium (or emanium, as it is termed by Giesel,) will probably prove to be an element of activity comparable with that of radium.

The radiations from these substances are invisible to the eye, but possess the properties of acting on a photographic plate and discharging an electrified body. The rays from a very active substance like radium cause many phosphorescent substances to become luminous. An ordinary X-ray screen, crystalline zinc sulphide and the minerals willemite and kunzite glow brightly when exposed to radium rays. A photographic plate is rapidly affected by bringing near a few milligrams of radium bromide, and an electroscope quickly loses its charge.

The radiations from the active bodies have been shown to consist of three distinct kinds, known as α, β, and γ rays. Unlike ordinary light-waves, the α and β rays consist of a flight of charged particles projected with enormous velocity. They differ from ordinary light, inasmuch as pencil of these rays is deflected by a magnetic and electric field. These properties of the radiations have allowed us to determine the size of the particle and its velocity of projection. Rutherford found that the α rays consisted of atoms of matter carrying a positive charge and moving with a velocity of about 20,000 miles a second. The α rays are readily stopped by matter, being absorbed by a few centimetres of air and by a sheet of ordinary note paper. The β particles, on the other hand, are far more penetrating and pass through several millimetres of aluminum or iron. The β particles differ from the α particles in carrying a negative charge and in their much greater velocity of projection. Some of them move with a velocity of over 170,000 miles per second — a speed very nearly equal to that of light. The β particle has been found by Becquerel and Kaufmann to be identical with the cathode particle produced by a discharge in a vacuum tube. It has the smallest size of any body known to science, for its mass is only about 1-1000 of that of the atom of hydrogen. The relative sizes and velocities of the α and β particles are diagrammatically shown in Fig. 1. The relative energies of motion of the particles are also shown.

The γ rays are of an extraordinarily penetrating character, readily passing through several inches of iron or lead and several feet of water. They are not deflected by a magnetic or electric field and are believed to be a type of very penetrating X-rays. The latter are believed to consist of pulses in the ether, akin in some respects to the very short waves of ultra-violet light.

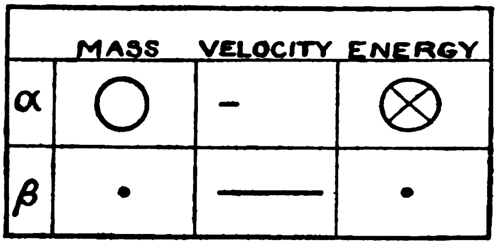


FIG. 1.

If a magnetic field is applied to a pencil of rays from radium, the rays are sorted out into the three kinds. This is shown in Fig. 2, where the magnetic field is applied at right angles to the plane of the paper. The α particles are bent to the left, the β to the right, while the γ rays proceed in a straight line without deviation. Compared with the β rays, the amount of bending of the α rays is much exaggerated in the figure, for a very strong magnetic field is required to appreciably deflect the latter. The β rays consist of particles projected with different velocities, so that some are more easily bent by a magnetic field than others. This is shown in the figure.

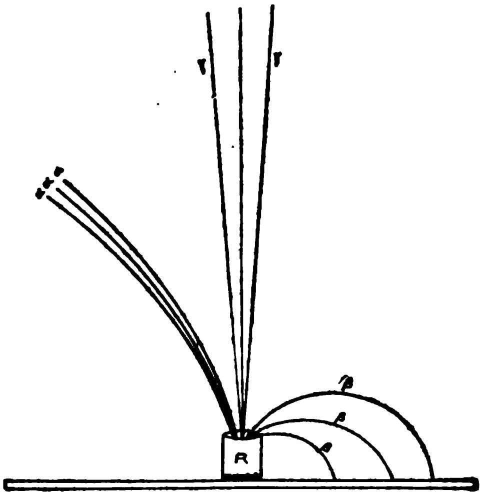
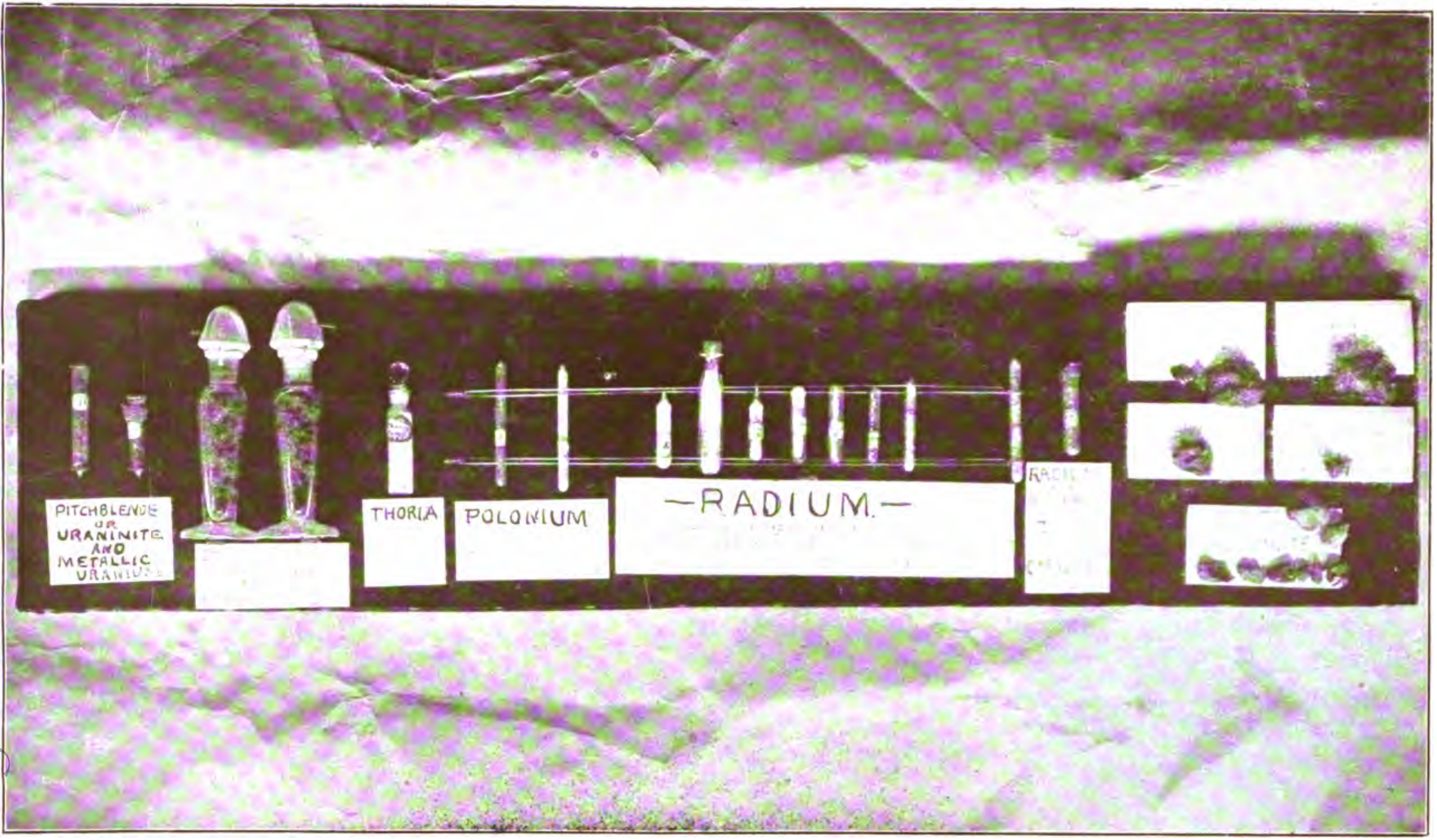


FIG. 2.

The expulsion of α and β particles from the atoms of the radioactive bodies appears to result from an explosion in some of the atoms of these substances. About two hundred thousand million of these α particles are expelled from one gram of radium bromide every second; and yet the number of atoms in a gram of radium is so enormous that this rate of expulsion can continue for several years without any



RADIUM AND OTHER RADIOACTIVE SUBSTANCES.

sensible alteration or diminution of the quantity of radium.

The most important property of the α, β, and γ rays is their power of discharging an electrified body, and this property has been utilized as a means of quantitative measurements of the radiations. The ordinary gold leaf electroscope, such as is shown in Fig. 3, can be used to measure radiations of extremely small intensity. A simple gold leaf is attached to a metal rod passing through an insulating cork of sulphur or ebonite. On giving a charge to this rod, the gold leaf diverges and, under ordinary conditions, the gold leaf collapses very slowly. If, however, a radioactive substance is brought near it, the charge on the system is dissipated and the gold leaf rapidly collapses.

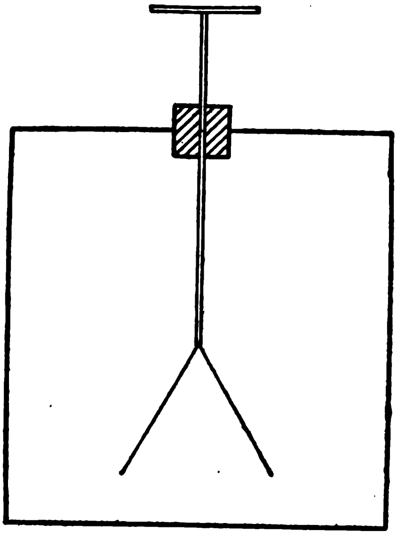


FIG. 3.

The radiations produce a large number of positively and negatively electrified particles or ions, as they are called, from the neutral gas. If the electroscope is charged positively, for example, the negative ions are drawn into it and dissipate its charge. Under suitable conditions, the rate of movement of the gold leaf is a measure of the intensity of the radiations. A modified form of gold leaf electroscope is capable of detecting the presence of an extraordinarily small quantity of radioactive matter. One millionth of a gram of radium bromide causes the gold leaf to collapse in a few seconds, and, with care, the effect of one million millionth of a gram can be accurately determined. As a means of detection of radioactive matter in small quantity, the electroscope far transcends in delicacy even the spectroscope. The ordinary quadrant electrometer is also a very convenient instrument for measuring the small ionization produced by the radiations in the air or other gas through which they pass.

In addition to their power of giving out the three kinds of rays, radium, thorium, and actinium also possess another very remarkable property. Each of these substances continuously gives off into the air a minute quantity of gas, which is itself radioactive. This «emanation,» first discovered by Rutherford in thorium, gradually diffuses from the radioactive body into the surrounding gas and can be carried away with a current of air. The «emanations,» however, only keep their power of radiating for a short time.

The activity of the emanation decreases in a geometrical progression with the time; the emanation from thorium loses half of its activity in one minute; from radium in four days; and from actinium in four seconds.

The amount of emanation obtained from these substances is a maximum when in solution; in a solid state only a fraction of the emanation produced in the substance is able to escape from it.

These emanations have been found to possess all the properties of radioactive gases mixed in minute quantity with the air. The emanations of thorium and radium behave like heavy gases and are chemically inert like the recently discovered members of the argon-helium family. The emanations can be removed from the air by the action of extreme cold. The emanation of thorium condenses at —120° C., and that from radium at —150° C. This property of condensation of the emanation from a very active substance like radium can readily be followed by the eye. The emanation released from radium is stored with air in a small reservoir (Fig. 4). It is slowly passed through a U tube of glass, filled with fragments of the phosphorescent mineral willemite. The tube is immersed in a vessel filled with liquid air. The emanation condenses in the tube immediately below the level of the liquid air, and the radiations from the condensed emanation cause the willemite to become luminous. On removal of the tube and closing the ends, the emanation, after some time, is again volatilized and distributes itself throughout the tube, causing a uniform luminosity throughout it. With a large quantity of radium emanation, such an experiment is extremely striking.

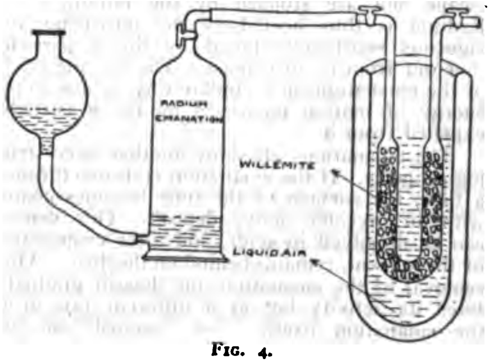


FIG. 4.

Ramsay and Soddy have succeeded in isolating the emanation of radium, and found that the maximum volume to be obtained from one gram of that substance was only one cubic millimetre at standard pressure and temperature. This gas is brilliantly luminous and rapidly blackens the tube containing it. The emanation has a definite spectrum of bright lines, similar in general character to that observed for the inert gases argon or helium.

Curie and Laborde first observed the striking fact that radium kept itself continuously at a temperature several degrees higher than the surrounding air. The radium is continuously emitting heat at the rate of 100 gram calorics per hour; that is, it would heat its own weight of water through 100° C. in one hour. Rutherford and Barnes showed that the greater part of the heating effect of radium was not due directly to the radium itself, but to the emanation continuously produced from it. This emanation was separated from the radium, and condensed in a small glass tube immersed in liquid air. The heating effect of the minute quantity of emanation thus obtained was found to be three quarters of that originally possessed by the radium. Compared with its weight, the radium emanation emits a quantity of energy more than a million times greater than that released in the most violent chemical reaction. The heating effect of the emanation is not, however, permanent, but dies away with the time at the same rate as it loses its activity; that is, it falls to half value in about four days.

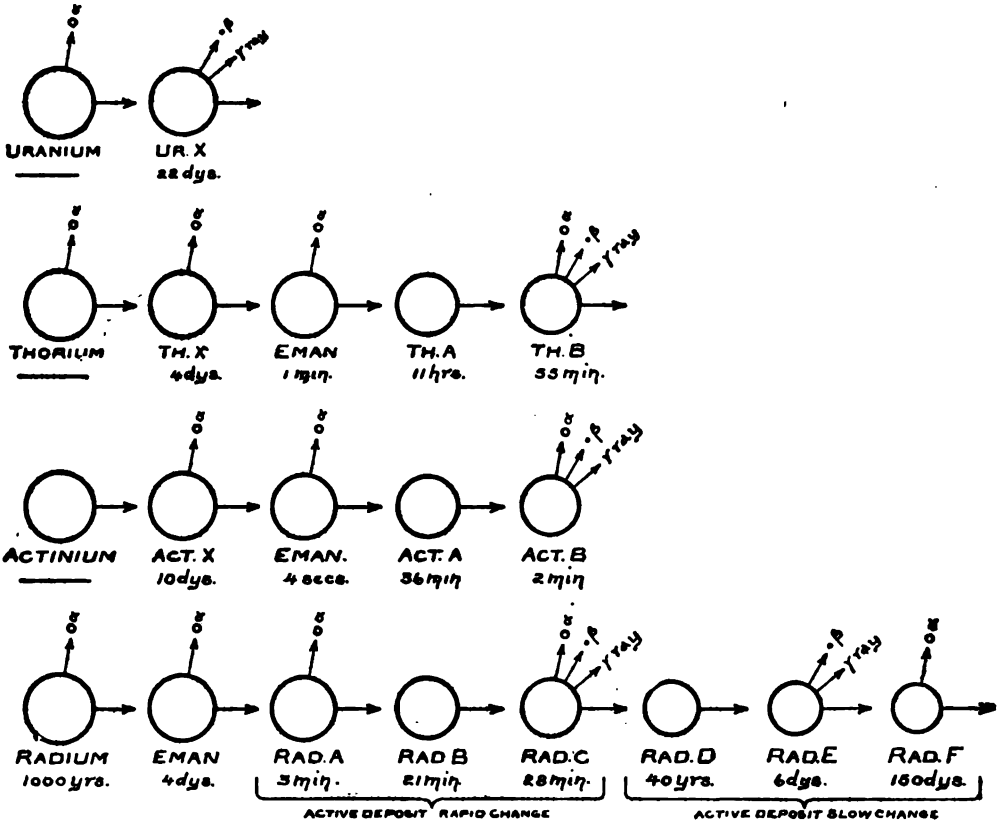
If a cubic centimetre of the emanation were collected in a glass tube, it would probably give off sufficient heat to melt down the walls of the tube. It can readily be deduced that one pound weight of the emanation, after its separation from radium, would emit energy at the rate of 10,000 horse-power and, during the time that its activity lasts, would emit an amount of energy corresponding to 60,000 horse-power days. The heating effects of radium have been found to be directly due to the expulsion of α particles from its mass. Each of these particles is projected with such a great velocity that it has considerable energy of motion, which is transformed into heat when it strikes a body. These α particles are easily stopped by matter and, in a mass of radium, most of the α particles projected throughout its volume are not able to escape, but are stopped by the radium itself. Radium is thus heated by the unceasing and vigorous self-bombardment by the α particles shot out from its own mass. The heating effect of the emanation, in a similar way, is due to the energy of motion possessed by the α particles expelled from it.

The emanations all show another very striking property. If the emanation is drawn through a tube, the surface of the tube becomes coated with an invisible active deposit. This deposit can be dissolved in acids, and after evaporation of the solvent, remains behind on the dish. After removal of the emanation, the deposit gradually loses its activity but at a different rate from the emanation itself. This "excited" or "induced" activity, as it is termed, is due to radioactive matter which arises from the decomposition of the emanation. The excited activity of thorium falls to half value in 11 hours, that of radium in about 30 minutes, and that of actinium in 36 minutes.

Considerable light was thrown on radioactive phenomena by some experiments of Rutherford and Soddy that will now be considered. It was found that an intensely active substance called thorium X could be separated by a single chemical process from thorium. If some thorium nitrate is dissolved in water and ammonia added, the thorium is precipitated. If the ammonia solution is then evaporated and ignited, a very active residue is obtained, several thousand times more active, weight for weight, than thorium itself. The thorium itself is at the same time deprived of more than half of its original activity. A very interesting result is then observed. The activity of this residue thorium X is found not to be permanent but to decay according to a geometrical progression with the time, falling to half value in four days At the end of a month, the activity is less than 1 per cent of the initial value. At the same time, the precipitated thorium regains its lost activity, such that the sum of the activity of the thorium and thorium X together is always the same, and equal to that of the original thorium before chemical treatment. At the end of a month's interval, the thorium has nearly recovered its old value, and a new quantity of thorium X can then be obtained by the same chemical operation. This process can be continued indefinitely provided sufficient interval is allowed to elapse between each precipitation for the thorium to regain its activity. These results are very simply and fully explained on the following hypothesis. A small fraction of the thorium atoms every second becomes unstable and breaks up with explosive violence, an α particle being projected during the process. After the expulsion of an α particle, the residue of the thorium atom is lighter than before and becomes the atom of the new substance, thorium X. This substance is again unstable and breaks up with the expulsion of α particles, half of the matter breaking up in four days. In ordinary thorium, there are thus two opposing processes at work. The substance thorium X is produced at a constant rate by the disintegration of some of the thorium atoms, and at the same time this thorium X breaks up and changes into another substance. A steady state will obviously be reached when the number of atoms of thorium X, which are produced per second, is equal to the number of atoms of thorium X which break up per second. The constant radioactivity of thorium may thus be likened to the constant population of a country, where the number of births is equal to the number of deaths.

It has been found experimentally that the property possessed by thorium of giving off an emanation belongs not directly to the thorium but to its product, thorium X. The amount of the emanation is always proportional to the amount of thorium X present, and thorium freed from thorium X does not emit any emanation. This shows that thorium X is the parent of the emanation. According to the disintegration theory, advanced by Rutherford and Soddy, the atom of the emanation arises as a result of the expulsion of a particle from the atom of thorium X. In a similar way it has been shown that the emanation is transformed into the active deposit which has been found to consist of two distinct substances called thorium A and thorium B. The former does not give out rays at all, and is half transformed in 11 hours. It changes into the substance thorium B, which gives out α, β, and γ rays, and is half transformed in 55 minutes. The active deposit usually consists of thorium A and B together. These two constituents can be separated from one another by electrolysis, or the same may be done by utilizing the differences in their volatility when subjected to heat.

These "rayless" products, of which there are now several examples, are of great interest. These substances are transformed without the appearance of any noticeable radiation. This may be the result either of a rearrangement of the parts of an atom, or may be due to the fact that the α particle is not released with sufficient velocity to produce ions in the gas. It is interesting to note that the chemical and physical properties of a rayless product can be determined by observing its effect on the succeeding product which emits rays. Thus we can learn the properties of a substance which we are unable to directly observe either by its weight or its radiations.



The process of analysis which has been applied to thorium has been applied with equal success to uranium, radium, and actinium. Sir William Crookes found that uranium has a product called uranium X, which is half transformed in 22 days and gives out only β and γ rays. The product actinium X was recently discovered by Godlewski. The radioactive properties of actinium are very similar, as will be seen from their stages of transformation given later. It is impossible in this short article to discuss in detail the experiments by which the presence and properties of these series of products, resulting from the transformation of the radio-elements, have been determined. The conclusions arrived at are shown diagrammatically in Fig. 5. The time for each product to be half transformed is placed below the product, and the radiations which accompany its transformation are also added.

It will be seen that seven distinct transformation products have been found in radium. The active deposit of rapid change arising from the emanation consists of three substances, called radium A, B, and C, which are half transformed in 3, 21, and 28 minutes, respectively. After these products have undergone transformation, a residue of very slight activity remains. The properties of this residue have been analyzed by Rutherford, who has shown that it breaks up through three successive stages, called radium D, E and F. The substance radium D does not give out rays itself, and is transformed very slowly — about half value in 40 years. The examination of this residue has brought to light the very important fact that radio-tellurium, and probably also polonium, are products of the disintegration of radium. The product radium F is identical with the radio-tellurium of Marckwald, for their chemical and physical properties are the same, and both lose their activity at the same rate. It has also been shown that radium D is probably the primary substance, which causes the activity observed in the radio-lead of Hofmann. The active substances present in polonium, radio-tellurium, and radio-lead are thus proved to be members of the radium family.

The products obtained from the radio-elements all possess some distinctive physical and chemical properties, which distinguish them not only from other products but also from the parent element. For example, radium — a solid substance with chemical properties closely allied to barium — is transformed into a gaseous substance, the radium emanation. The emanation in turn is transformed into a solid. Each of these products must be considered a distinct chemical substance. They differ from the ordinary chemical elements in the fact that they are unstable and undergo transformation into other or new kinds of matter. On account of their very limited life, these products exist in very minute quantity, and it is only in the case of a comparatively slowly changing product like the radium emanation that a sufficient amount can be obtained to measure. There is no doubt, however, that both radium D and F will ultimately be obtained in sufficient quantity to obtain their spectrum and chemical constants.

In the radio-elements, we are witnessing the transformation of matter through a series of successive stages. The products represent the halting places where the matter is able to exist a short time before it breaks down into new forms. This process of transformation is spontaneous and, as far as observation has at present gone, cannot be hastened or retarded by any physical or chemical agencies.

Since the radio-elements are steadily being transformed, the original matter must slowly disappear and be changed into other kinds. It can be calculated with some confidence that radium will be half transformed in about 1,000 years. A feebly active substance like uranium will probably take one thousand million years to be half transformed. The radio-elements apparently only differ from their products in their length of life; that is, in the stability of the atoms composing them.

A mass of radium left by itself would, in the course of 20,000 years, be almost completely transformed. Since the age of the minerals in which radium is found is known to be much older than this, it is necessary to suppose that radium is constantly produced from some other substance. The most likely parent of radium is the heavy element uranium, with which it is always found associated. Such a view has been strongly confirmed by recent investigations of Boltwood, Strutt, and McCoy. Boltwood has found that the amount of radium in different radioactive minerals, obtained from different parts of the world, is always proportional to their content of uranium. Such a relation indicates that radium is derived from uranium. If this is the case, a quantity of uranium, initially freed from radium, should in the course of time produce some radium. Such a growth of radium from uranium has actually been recorded in some recent experiments by Soddy and Whetham. The rate of production observed is, however, much slower than is to be expected if uranium passes directly into radium. The evidence is thus very strong that one element uranium produces another distinct element radium, which is quite distinct in chemical and physical properties from its parent.

In Fig. 5, we have given the series of bodies produced by the transformation of the radio-elements. But this process of transformation must ultimately come to an end and we should thus expect that the final product should be inactive, and probably consist of a known element or elements. Now the substance lead is always found in small quantity in minerals, and it is possible that this substance may prove to be the final or end product of radium.

The radioactive minerals must be considered as nature's laboratory in which all the products of transformation of the radioactive substances will be found. Rutherford and Soddy early suggested that the rare gas helium, which is always found associated with the radioactive minerals was a transformation product of the radio-elements. This prediction was verified by some very striking experiments made by Ramsay and Soddy. They removed the emanation from a quantity of radium and collected it in a tube. A discharge was passed through this tube and the light examined by a spectroscope. After standing several hours the spectrum of helium was observed, showing that this gas had been produced during the transformation of the emanation. Here again we have an example of the production of one element helium from another.

It seems likely that the α particles which are projected from the radio-elements are in reality helium atoms, but the amount of helium produced from radium is so small and difficult to measure that it is not easy to definitely settle the question of the position which helium occupies in the scheme of transformation outlined in Fig. 5.

The helium found in radioactive minerals is thus a decomposition of radium and probably also of the other radioactive substances present in it. It seems likely that we shall be able to form a rough estimate of the age of the radioactive minerals by measuring the amount of helium found in them, since for a given amount of radioactive matter present, the amount of helium will be greater, the longer the mineral has been formed.

Although radium is found in the greatest quantity in the mineral pitchblende, it is also found distributed in minute quantity over the whole surface of the earth. This has been clearly brought out by the long series of investigations made by Elster and Geitsel of the radioactivity of different soils and of the atmosphere. J. J. Thomson, Himstedt, Strutt and many others have found that the radium emanation is present in springs and in well water. Bumstead and Wheeler found that the air and surface waters of New Haven, Connecticut, was impregnated with the radium emanation. Strutt and Allan have observed that the famous Bath springs contain a considerable amount of radium emanation, and the former has also shown that the water contains a minute amount of radium in solution. A similar result has been noted for the waters at Baden and elsewhere. It has been suggested that the curative properties of these hot-water springs may possibly be due to the presence of radium or the radium emanation. This has, however, by no means been established.

The atmosphere is found to always contain a small quantity of the radium emanation. This does not come from the atmosphere itself but diffuses up from the soil or is carried up by spring water. A large amount of investigation has been carried out to determine the amount of emanation present in the atmosphere at different localities and under varying atmospheric conditions.

It has been suggested that the internal heat of the earth may be, in part at least, kept up by the heat liberated by the radium and other radioactive matter present in it. Observations, that have so far been made, seem to show that the amount of radium in the surface crust of the earth is sufficient to supply as much heat to the earth as is lost by conduction to the surface from the hot interior of the earth. It is only necessary that radium should exist in the earth to the extent of four parts in one hundred million million to account for the maintenance of the internal heat of the earth. The amount of radium or equivalent amount of other radioactive matter present in the earth cannot be greater than 270,000,000 tons or otherwise the earth would be growing hotter.

It is not possible to discuss here the physiological actions that are produced by radium rays. A large number of experiments have already been made and the literature of this branch of the subject is already extensive and is very rapidly growing. E. RUTHERFORD,
Prof. of Physics, McGill University, Montreal.

Radiom'eter, an instrument used to measure mechanical effect of radiant energy. It consists of four crossed arms of very fine glass, supported in the centre by a needle-point having at the extreme end thin disks of pith, blackened on one side. The instrument is placed in a glass vessel exhausted of air, and when exposed to rays of light or heat the wheel moves more or less rapidly in proportion to the strength or weakness of the rays.

Ra'diophone, an instrument that transmits or produces sound by means of radiant energy, particularly a device similar to the photophone, whose receiver is a block of vulcanite, with no telephone, the vibratory contraction and expansion being produced by the heat of the beam while vibrating, which is accompanied by an audible sound.

Radiotherapy is a term broadly used to designate the uses of the X-rays in the treatment of disease.

Scarcely had the diagnostic wonders of the X-rays been brought before the world by Professor Röntgen than X-ray operators and clinicians became cognizant of the deleterious effects which sometimes followed prolonged or frequent exposures for diagnostic purposes.

Partial or complete loss of hair over the part rayed; atrophy of the nails, and inflammations and destructive disturbances in the skin followed, varying from a simple redness, or a transient dermatitis to extensive ulcerations which healed most unkindly if at all.

It was only a step farther to adapt this little known and powerful agency to a beneficent purpose.

Within two years after Röntgen published his original paper, Freund* detailed the results of two experiments in the treatment of hypertrichosis (superfluous hair on face), in which a disappearance of the hairs followed frequent and prolonged exposures. In one of the cases reported by Freund after a number of exposures which aggregated over 40 hours, a violent and severe inflammation of the skin was set up which finally resulted in ulceration and necrosis.

The caustic action of the X-rays as seen in this case suggested to Schiff of Vienna the possibility of its use in the treatment of lupus vulgaris.

Independent of the work of Schiff and deducing his reasons from an entirely different hypothesis, Dr. Philip Jones of San Francisco as a result of the studies of the action of X-rays on a photographic plate, claimed and proved that the X-rays would cure lupus.

Dr. Jones' theory was that: the action of the X-rays on a photographic plate was a decomposing one, hence the X-rays ought to break down the highly organized lupus tissue. His results proved the soundness of his theory.

The fact that hypertrichosis and lupus, two of the most intractable diseases that bothered the dermatologist, could be successfully combated by the X-rays, naturally gave a great impetus to radiotherapy.

The already large number of X-ray investigators working along diagnostic lines quickly turned their attention to the therapeutic action of the rays and the literature soon became extensive.

Many intractable skin diseases readily cleared up under the action of the rays. Closely following the successful results in lupus, epitheliomas or skin cancers, rodent ulcers, and new growths of that type showed the favorable results of this treatment.

The breaking down of these highly developed tissues naturally led to the treatment of ulcerating breast cancers, scirrhus or hard breast cancers, and finally the attempt to eradicate internal cancers, with the results at present still in doubt. Accompanying many of the conditions treated was pain.

It soon became recognized that after a certain number of treatments the pain was oftentimes materially decreased, and in some instances entirely disappeared, hence it naturally followed that the X-rays were used in many painful affections of the nerves, neuralgias, sciaticas and for the relief of pain in inoperable cancers.

From an observation of the action of the X-rays on cancerous glands, treatment of enlarged glands from other causes was instituted and soon favorable results were recorded in cases of tubercular glands, Hodgkins disease, spleno-medullary leukemia and many allied conditions. Tuberculosis in all its varied manifestations soon was given a thorough trial. The results were eminently satisfactory in some forms, but disappointing in consumption and diseases of the bones and joints.

Having attempted to trace the beginnings of radiotherapy and the investigations which led up to it: How the action of the rays in certain conditions gradually and methodically paved the way for its employment in others, it might be advantageous here to take up the means and methods whereby these results are obtained and the protection and safeguards necessary for their successful attainment.

Apparatus.—Any form of apparatus that can successfully develop Röntgen rays may be used in radiotherapy.

The three principal styles in use are (1) the induction coil, (2) the static machine, (3) the height frequency or Tesla apparatus. The last named is so seldom used that a discussion of its merits may be dismissed.

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*Wiener Med. Woch. 1897.

Some operators prefer the static machine to the coil and claim better results for the former, while workers with coils claim the opposite.

Most men who have an opportunity to employ both recognize no great difference. It is probably true that more inefficient work is done with static machines than with coils because many static machines employed fail to develop sufficiently heavy electrical discharges to satisfactorily illumine a practical tube while capable of doing satisfactory static work. Most coils employed are sufficiently large to overcome this difficulty.

A great many factors are present in determining the intensity and quality of the rays. The amperage must be low, between one and four amperes, but the voltage may range from 12 to 110 volts.

Tubes.—In radiotherapy the tube is one of the most essential elements that control results. The character of the tube will largely be governed by the results sought. Tubes invaluable for the treatment of certain conditions are useless for the treatment of others. For hypertrichosis a rather low tube with short penetration accomplishes the most successful results, because here we seek an absorption of the rays around the hair follicles. The same is true of any thin-surfaced skin disease. But in treating morbid conditions of the deeper parts a tube is needed with a higher vacuum, because here we aim to have the rays penetrate the skin unabsorbed and act on the affected parts underneath.

There are in use three principal styles: (1) The unregulated X-ray vacuum tube. (2) The tube with a regulated attachment, whereby the vacuum of the tube may be lowered when it becomes too high, by heating a metallic needle which projects from the tube. This needle upon being heated liberates gases in the tube which lower the vacuum. This style of tube has a much longer life than a tube of the preceding style, and is quite satisfactory for radiotherapeutic work. (3) The highest type of tube is the one with the self-adjusting vacuum; a tube under absolute control even when excited. This tube does excellent work, is essential for the finer grades of radiographic work, but it is costly, punctures more readily and its advantages in radiotherapy do not compensate for its added cost. There are various special tubes manufactured for the treatment of special parts, as the larynx, vagina, rectum. These have their advantages.

Distance.—The distance of the tube or the cathode from the part to be treated varies with the conditions to be treated and the character of the tube. In those diseases where it is desirable to set up an action in the skin quickly, the tubes may be placed so that the outside of the glass is within two or three inches of the part treated. When treatment is to be continued for a long time and an inflammatory action is guarded against, the tube may be removed 12 to 15 inches.

Protection.—Most operators at the present time use a metallic protection to the normal parts, either lead or tinfoil. Grounded aluminum shields have been used, but they are unnecessary. Liquid paraffine and substances with an ointment base have been tried, but they do not offer sufficient protection. Many men in treating recurrent cancers place the tube at some distance from the patient, and use no protection. This has the advantage that widely infected areas are acted upon.

Exposures.— Exposures may be made every day, every other day, twice a week or by Kienböcks* method, which seeks to accomplish a therapeutic effect oftentimes with a single exposure from a heavy coil and an intense light. When given daily, treatments are generally short, five minutes. The generally accepted plan is to expose the patient three times a week from 8 to 15 minutes, varying with the condition to be treated. It is practically accepted that there is an idiosyncrasy among some persons to the influence of the rays, and the most cautious operators give a preliminary exposure to determine this susceptibility to X-ray action.

Dermatitis.— There is no more debatable question in the whole realm of X-ray work than the question of the X-ray burn. A discussion of the pathology of X-ray dermatitis is foreign to the subject at hand; if interested the reader is referred to the works of Williams, Pusey and Caldwell, and the experiments of Prof. Elihu Thomson and others. It is sufficient to know that in the treatment of many diseased conditions it is wholly unnecessary to set up a dermatitis. Lupus, sycosis, cutaneous cancer and the malignant ulcerations can be entirely healed without producing inflammation of the skin beyond a slight redness or a tan. That this is so entirely disposes of the theory that the action of the X-rays in curing disease is caustic or escharotic. While it is wholly unnecessary to produce a burn to cure, in many cases haste is so imperative that in order to quickly get a patient under the influence of the rays all caution must be set aside.

Indications for Radiotherapy.—The following classification is given by Pusey†: (1) The effect in causing atrophy of the appendages of the skin; (2) their destructive action upon organisms in living tissues; (3) their stimulative action upon the metabolism of tissues; (4) their power of destroying certain pathological tissues; (5) their anodyne effect.

Under one class may be included the action of the rays in removal of superfluous hair or in alleviating conditions due to parasitic affections of the hair or its follicles: hypertrichosis, sycosis, favus, tinea-tonsurans, tinea-barbæ. In this class of cases the results of treatment are completely curative. The removal of superfluous hair from ladies' faces (complete patches) during one course of treatment is so far superior to the long, tedious, painful method of destroying each individual hair follicle by the electric needle that it requires no comment. Sometimes, if the reaction is not sufficiently severe, the hair may recur in a lessened amount. but a second series of treatments usually will produce a permanent cure.

Another group of cases would include the inflammatory diseases of the skin: Lupus-erythematosis, acne, chronic indurated eczema, lichen planus, psoriasis and affections of that class. In this group are many diseases, the medical treatment of which is entirely satisfactory. The most intractable and unsatisfactory condition in this class is probably lupus erythe-

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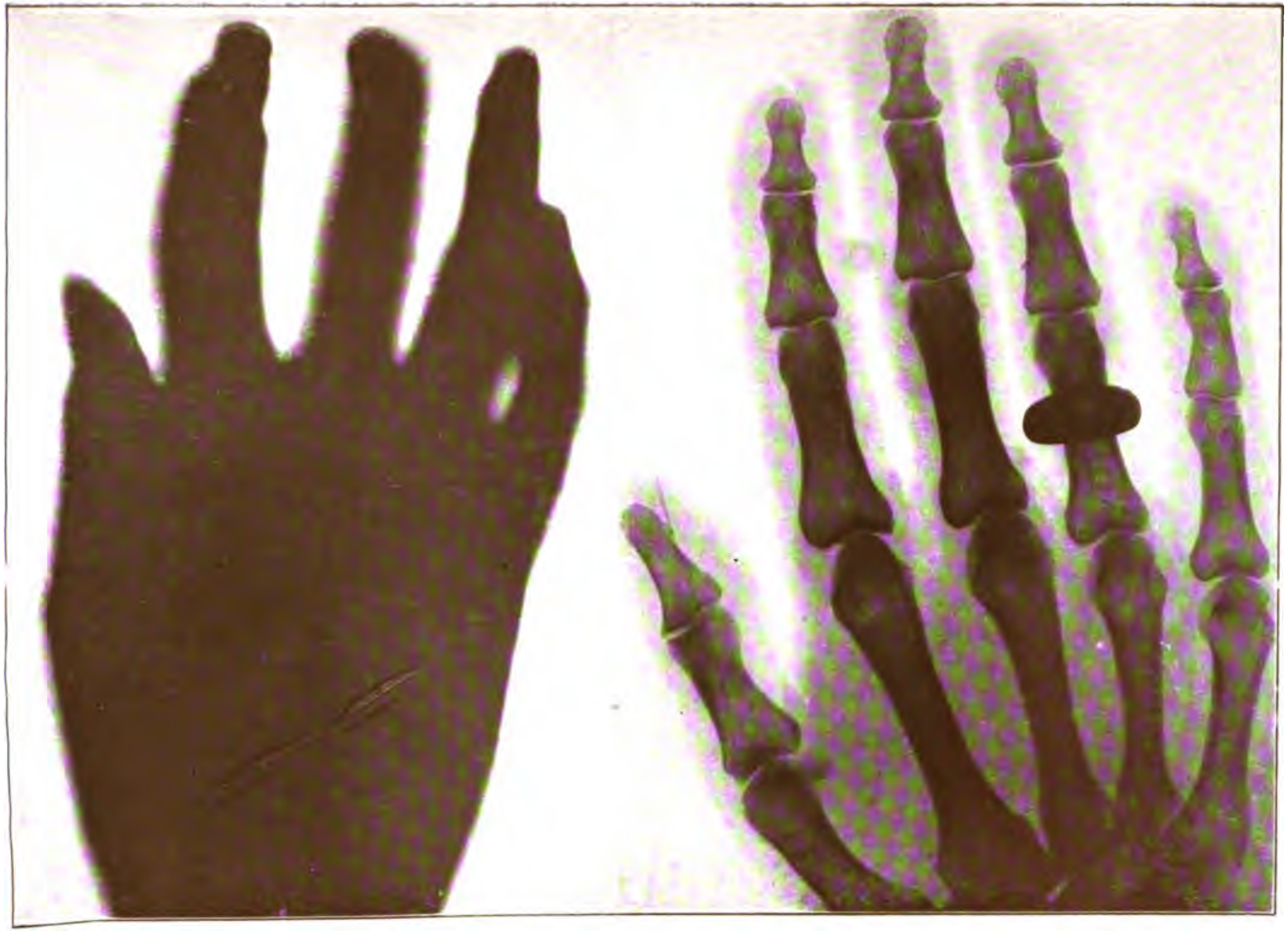
*Interstate Med. Journal, 1902, ix., pp. 1–60.

†Pusey & Caldwell, "The Röntgen Rays in Diagnosis and Therapeutics."



1. Radiograph of the human hand (dead) made by radium.
2. Radiograph of the human hand (living) made by "X" rays.

matosis. This disease is characterized by its tendency to remissions, and, unfortunately, it retains its characteristics when treated by the X-rays. There have been many cases of lasting cures, but that there are many other cases which recur after recovery seems probable, and some that radiotherapy does not beneficially affect.

There are many diseases which are caused by the action of bacteria in the skin, and subcutaneous tissues, in which there are obtained most brilliant, positive and curative results by the action of the Röntgen rays. Although the evidence is conflicting, yet it is generally accepted that the X-rays exert little or no bactericidal power on germs in culture media, but it is just as positive that the X-rays most powerfully affect diseased tissue containing germs. Whether this action is due to a stimulating effect upon the tissues themselves, making them a less receptive host for the bacteria, or whether it acts directly and destructively on bacteria and their products in living tissue, is still *sub-judice.*

The most remarkable results obtained in this class of cases are in lupus vulgaris. Before the epoch-making work of Finsen, of Copenhagen, the treatment of lupus vulgaris was most discouraging. The most persistent and continuous treatment, from cauterizations to extensive plastic work of the surgeon, could only for a time arrest the slow but steady destructive ulcerations. Some few cases were cured, but the percentage of recoveries was small, until Finsen showed his lasting cures by the ultra-violet rays. The treatment of Finsen leaves little to be improved upon so far as results go. But the treatment is unsatisfactory because of the expensive equipment, duration of each treatment, pain during treatment, and time required to effect a cure: it sometimes taking a year of almost daily treatment to eradicate a patch of an inch.

The results of X-ray therapy seem equally as good as Finsen's, while 15-minute treatments, 6 to 20 times, and given every other day, accomplish the same results. In treating lupus by means of the X-rays, the most lasting and successful results are obtained in the deeply ulcerated cases by establishing a severe dermatitis. While in the surface inflammations we may obtain a cure without producing the slightest effect on the surrounding normal skin.

At the present the X-rays seem to offer hope of a permanent cure in many of the non-malignant glandular enlargements, where it acts by breaking down tissues of low vitality without injuring the healthy connective tissues. Tubercular glands in the early stages show a fair percentage of cures. Hodgkins disease — an almost universally fatal condition — has shown many authentic cures, and recently Senn and others report cures of spleno-medullary leukemia. Care must be taken not to break down the glands too rapidly, as the large amount of decomposition products with the toxine of the disease thrown rapidly into the circulation sometimes produces severe systemic disturbances.

The consideration of the treatment of new growths, and more especially cancer and sarcoma, must necessarily be brief. The X-rays may be used in the treatment of new growths for its palliative, curative or anodyne effect. The results of the X-ray treatment of sarcomas seem to point not to a curative but a retarding effect. For the better understanding of the cancerous conditions we may divide the subject into the epitheliomas or skin cancers and the sub-cutaneous cancers, including those which are beneath the tissues and cancers of the internal organs.

For most of the skin cancers X-ray treatment should be the treatment of election. Where there is no disease in the glands or other organs, treatment of a well-defined skin cancer by the X-rays is curative. Sufficient time has elapsed since the early reported cases to induce the belief that the cures are lasting.

Cancers of the tongue and mucous membranes are seldom successfully treated by the X-rays. In these conditions growth is very rapid, and death usually inevitable after any treatment. And it may be considered as an axiom, in X-ray therapy, the more chronic the disease the more likely the cure. At the present time and with our present apparatus and experience the cure of subcutaneous cancers appears very doubtful. Early excision still offers the best chance to cure, but it is in these cases that have been operated upon that much good can be done by radiotherapy subsequent to operation. Treatment of subcutaneous cancers by the X-rays prior to operation did not yield the results expected, but treatment of these cases after operation will forestall an oncoming recurrence and may possibly prevent it altogether. Here the results are most satisfactory. In the advanced cases of the disease — the inoperable cases — much can be done in prolonging life and in curing up ulcerations, retarding the disease, and controlling pain by systematic X-ray treatment.

JOHN A. LEE, M.D.

Radish, several species of herbs of the order *Cruciferæ.* The common garden radish (*Raphanus sativus*) is thought to be a native of Asia, but is not known in a wild state. It is cultivated for its edible roots, which in various varieties may be red, white, gray, brown or black, and vary in form from turnip-shaped to parsnip-shaped. They reach edible maturity in from three weeks or less when forced. Radishes thrive best in rich, light, well drained sandy loam. Out of doors the seed may be sown as soon as the soil can be worked, since the plants are very hardy. The seeds may be dropped about an inch apart, covered an inch deep, in rows a foot asunder in beds by themselves, or, as in market garden practice, may be sown between slower-growing crops, such as carrots, cabbage or peas. Sometimes they are even sown with the seed of parsnips, onions and other crops that are either slow to germinate or that are very inconspicuous when they first appear. They then serve to indicate the positions of the rows, so that cultivation of the other plants may begin much earlier; they must then be removed promptly to prevent injuring the main crop. For succession, the seed should be planted at intervals of a week or ten days. Winter radishes are sown from midsummer to early autumn, and when cold weather arrives are stored in pits or cellars like other roots. Clean cultivation is essential. A Japanese species (*R. caudatus*) is popularly cultivated in Asia for its long pods which are eaten raw or pickled. It is known as the serpent or rat-tailed radish. The pods are often a foot long. The roots are small, hard and inedible. The sea radish (*R. maritimus*) is more pungent than the garden species and is little known in American gardens. Horseradish (q.v.) belongs to a different genus, *Cochlearia.* Many of the insects which feed upon cabbage, turnip, mustard and related plants also feed upon the radish. The best known is the radish maggot which is the larva of a brown fly (*Phorbia brassicæ*). The maggots tunnel in the fleshy part of the root and injure it for human food. Applications of fertilizers, especially quickly soluble ones, and rotation of crops have been recommended as preventives. Consult, Bailey, 'Cyclopedia of American Gardening' (New York, 1900–2).

Radistcheff, Alexander Nikolaievich, Russian author: b. Moscow 1749; d. there 1802. He was descended from a noble Russian family, and after spending several years at court as a page, was sent to be educated at the University of Leipsic. He returned to Russia in 1771, and obtained a position in the department of customs. He had been deeply impressed during his absence by the writings of the French philosophers of the time, and in 1790, under the influence of his liberal sentiments, he wrote his famous 'Journey from Saint Petersburg to Moscow,' patterned somewhat after Sterne's 'Sentimental Journey.' This work is a most striking picture of Russian serfdom as it existed at the time, and contains a plan of emancipation, all the more bold for its appearance in a period of reaction. The author was sent to Ilimsk, in the government of Irkutsk, by the Empress Catharine, but was allowed to return to Russia in 1796. He was made a member of the legislative commission in 1801.

Radium (from Latin, *radius,* ray), symbol Ra, discovered in 1898 at Paris by Professor Pierre Curie and Mme. Sklodowska Curie in collaboration with M. Bemont. It is the most important and most interesting of the radioactive substances which have thus far been found in uraninite or, as it is termed in popular parlance, pitchblende. (See PITCHBLENDE.)

Radium, which resembles common table salt in appearance, is a new element having an atomic weight of 225. In its chemical and other characteristics, it resembles barium, with which it is closely allied and which latter substance has an atomic weight of 157.

Radium is a metal, and while it is never prepared in a metallic form, it readily could be so produced, although only at a great loss involving perhaps thousands of dollars, but it would not last in this form, being very unstable and, like sodium, immediately oxidized and destroyed. In the form of a chloride or a bromide, in which forms it is usually prepared, it lasts indefinitely without any apparent physical or chemical change. Professor Henri Becquerel has stated that if a square centimetre of surface was covered by chemically pure radium it would lose but one thousandth of a milligram in weight in a million years time. Similar statements have been made, by Professor J. J. Thomson and others, tending to show that, notwithstanding the enormous amount of energy given off by radium in producing its remarkable chemical, physiological, luminous, thermal, electrical, and other effects, there is no appreciable loss in weight nor any microscopic, spectroscopic or chemical change in the original body.

Among the remarkable characteristics of this extraordinary substance may be cited the following:

It gives off three distinct types of rays named after the first three letters of the Greek alphabet, Alpha, Beta and Gamma. The Alpha rays constitute about 99 per cent of all the rays and consist of positively electrified particles. These were at first supposed to be uninfluenced by magnetism, but Rutherford has recently shown that with a powerful magnetic field about 30 per cent of the rays are deflected and in a powerful electric field as high as 45 per cent are deflected. The deflection is in the opposite direction to the Beta rays. The mass of the Alpha body is about twice that of the hydrogen atom. They have scarcely any penetrative power and are readily absorbed in passing through a sheet of ordinary note paper or a few inches of air.

The Beta rays, which are the most spectacular of the rays and have been given the largest amount of attention by investigators, consist of negatively charged particles or "corpuscles" approximately one two-thousandth the size of those constituting the Alpha rays. In every particular these rays resemble the cathode rays produced by an electric discharge inside of a highly exhausted vacuum tube, although they work at a higher velocity than the cathode ray particles. They are readily deflected by a magnet, discharge electrified bodies, affect photograph plates, stimulate strongly phosphorescent bodies and are of great penetrative power.

The Gamma rays are very few in number, so few in fact that they have received little attention thus far. They are almost impossible to detect save in a highly radioactive substance such as radium. They resemble in many respects very penetrative X-rays produced at the moment of the expulsion of the Beta or cathode rays. They are uninfluenced by magnetism, pass in straight lines at great speed and possess remarkably penetrative properties, even affecting a photograph plate through a foot of iron.

It gives off a gaseous emanation, as does thorium, which is also a powerfully radioactive substance. (See THORIUM.) The emanations possess all the properties of gases: diffusing through air and porous substances such as paper, they can be stored like ordinary gas and can be condensed at a temperature of liquid air, and are unaffected by chemical reagents.

It ionizes the air or makes the air (in fact, any gas through which it passes) a conductor of electricity.

It discharges negatively electrified bodies.

It is, according to Mme. Curie, the first example of a body which spontaneously charges itself with electricity.

It acts upon the chemical constituents of glass, porcelain and paper, giving them a violet tinge, changes white phosphorus into yellow, oxygen into ozone, affects photograph plates and produces many other curious chemical changes.

It imparts radioactivity to everything surrounding it. (See RADIOACTIVITY.)

P. Curie

M. Curie

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THE DISCOVERERS OF RADIUM

It destroys the germinative power of seeds.

It likewise destroys various micro-organisms and checks the growth of others.

It has given encouraging results in the treatment of certain classes of disease, but it is too early as yet to state positively to what extent it can be used in medicine and surgery. Owing to its scarcity and high cost, but few have been able to experiment with radium, and insufficient time has elapsed to prepare specifications for its use or to state with positiveness what its limitations are in this field. It has produced paralysis and death in fish, mice, rabbits, guinea pigs, and other animals, and would undoubtedly similarly affect human beings. Professor Curie has told the writer that he would not care to trust himself in a room with a kilo (2.2 pounds) of radium, for it would destroy his eyesight, burn all the skin off his body, and probably kill him, and he has recently said that a single gram of chemically pure radium could destroy the life of every soul in the city of Paris, provided they were separately and properly exposed to its influence.

It retards the growth of certain forms of life such as larvæ, so that they do not pass into the chrysalis and insect stages of development, as their companions do; but remain larvæ.

It causes other forms of life, such as very young tadpoles, to become monstrosities or abnormalities. It causes the hair of mice to fall out, and they run about without a hair on them, and, if the radium is placed closer, the mice are paralyzed and killed. On the other hand, it causes a growth of the hair or fur of rabbits when they are exposed to radium placed at a proper distance.

It has produced partial paralysis in the "Torpedo Galvani," or electric ray, on a comparatively short exposure, so that it could no longer give its powerful electric shocks.

It has frequently caused serious burns and ulcers when placed near the flesh for a short time, the rays acting through the clothing of the person exposed, and, in fact, to a greater or less degree passing through everything, solids, liquids and gases, even through many inches of steel.

It is not affected by great extremes of heat and cold in respect to its radioactivity, but varies in the degree of its luminosity.

It gives off but little light, its luminosity being largely due to the stimulation of the impurities in the radium by the powerful but invisible radium rays.

It affects photographic plates placed in opaque envelopes, which plates, so protected, would not be affected even though exposed to bright sunlight for 24 hours, as ordinary light does not penetrate opaque substances. Ordinary light is also reflectable, refractable and polarizable, whereas the Becquerel rays coming from radium do not possess these characteristics. By reason of the foregoing the pictures of objects produced on the negative by radium and other radioactive substances cannot properly be called photographs; they are in reality radiographs.

It has a temperature, as discovered by Professors Curie and Laborde, of between five or six degrees Fahrenheit above its surroundings and will melt its own weight of ice every hour for an indefinite period.

It may prove ultimately that the alchemists of old were not so far wrong in their belief in the transmutation theory, for Sir William Ramsay and Professor Soddy have demonstrated that helium, one of the new elements discovered in the atmosphere by Professor Ramsay and which constitutes the gas most prevalent in the sun's atmosphere, is shown by the spectroscope to be present in the gaseous emanation from radium, and Professor Ramsay states that eventually the entire emanation turns into helium, proving, so he claims, that one element can change into another.

It constitutes an absolute test of the genuineness of a diamond, causing diamonds to phosphoresce strongly when brought near the radium, whereas imitation stones will glow but little, if at all.

It not only imparts radioactivity to cardboard, metals, etc., but such substances made radioactive on being placed near the radium can be stimulated by the vibrations from sunlight, burning magnesium, ultra-violet light, an electrical brush discharge, etc., so that the object will glow beautifully in the dark. Freshly fallen snow and rain and certain mineral springs and baths are radioactive; even the leaves of trees, blades of grass; in fact, practically everything in nature may be said to possess this property in some degree, and a fine wire charged with negative electricity of approximately 500 volts will become coated with radioactive properties, collected from the atmosphere, and this deposit can then be scraped from the wire and used.

It imparts radioactivity to anything adjacent to it, and the coating thus formed is so adhesive that water cannot wash it off, although it can be removed with ammonia.

It also imparts a beautiful carmine color to a flame in which it is burned.

It stimulates powerfully various mineral and chemical substances near which it is placed, and, substances such as willemite, sulphide of zinc, etc., in a powdered form, having a little radium mixed with them, are thus made to glow very brightly in the dark for an indefinite length of time, and there is promise in this direction of securing an efficient illuminating agent without flame and without appreciable heat.

It is found in a smaller percentage in pitchblende and other radioactive substances, according to Prof. J. J. Thompson, than the percentage of gold which is found in sea water.

It takes, says Professor Curie, 5,000 tons of uranium residues, that is, pitchblende, after the uranium has been extracted, to make a kilo (2.2 pounds) of radium, and this product by no means radium in its purest state.

It formerly took three months, and even now takes about one month, to work the process, and it costs about $2,000 a ton to refine the uranium residues.

A bibliography of radium, even at this early date, would be very extensive; among the publications containing the most important contributions are The Phil. Mag., Comptes Rendus, Ann. der Physik, Revue Gen. des Sciences, Nature, Jour. de Phys., Soc. Française Phys. Bulletin, Chem. News, Phys. Ges. Verk., Phys. Zeit. Science Abstracts, Wien. Ann., Ber. Dtsch. Chem. Ges., Proc. Royal Soc., etc.

William J. Hammer,
Consulting Electrical Engineer.

Ra'dius, the bone of the fore limb of vertebrate animals, which, as in man, when the arm is laid flat, with the palm upward, lies to the thumb side of the limb. This side is therefore termed the *radial* side of the limb, in contradistinction to the *ulnar* or opposite side, so named from the ulna or neighboring bone, which, with the radius, constitutes the forearm. See ARM.

Radius in geometry. See DIAMETER.

Radius Bar, or **Radius Rod,** one of the guiding-rods in a parallel motion, jointed to the connecting links, to counteract the vibratory motion communicated by the beam by guiding the links so that the head of the piston rod may reciprocate in a line sensibly straight.

Radius of Curvature. See CURVE.

Radius Vector. See MATHEMATICS.

Ra'dix. See ROOT.

Radom, rä'dŏm, Russian Poland, (1) capital of the government of same name, 65 miles south of Warsaw, and one of the best-built provincial towns. Its special features are an ancient church and convent. Its manufactures are of tin, oil, vinegar and leather. Two fairs are annual attractions. Pop. 25,000. (2) The government covers an area of 4,768 square miles, and has a pop. of about 830,000.

Radowitz, rä'dō-vĭts, **Joseph Maria von,** Prussian statesman: b. Blankenburg, Germany, 6 Feb. 1797; d. Berlin, Germany, 25 Dec. 1853. He was of a noble Hungarian family, and in 1813 entered the Westphalian army as an officer. In 1823 he entered the Prussian service, and in 1830 became chief of the general staff of artillery and a leader of the anti-revolutionary party. He subsequently held diplomatic posts at Carlsruhe, Darmstadt, and Nassau, was the confidant and adviser of King Frederick William IV., and after the revolution of 1848 supported the efforts of Prussia to give a constitution to Germany. He wrote several works, mainly political, which include: ‘Gespräche aus der Gegenwart über Staat und Kirche’ (1846–51); (Gesammelte Schriften’ (1852–3); etc.

Radziwill, räd'zē-vĭl, ancient Polish family. Among its most famous members are: (1) Nicholas the Black, son of John the Bearded, and palatine of Wilna; d. 1567. King Sigismund Augustus gave him the command, in 1552, in the war against the Polish knights. He also commanded in the war against Russia in 1561. Having become a convert to the Reformation, he procured a translation of the Bible into the Polish tongue (Biblia swieta, Brzesc, 1563). (2) Christopher II., military governor of Lithuania and palatine of Wilna. b. 1585; d. 1640. After the death of Sigismund, in 1632, he undertook the defense of the Protestants at the Diet of Warsaw and obtained complete toleration for them. Enjoying the confidence of Wladislaw IV. he commanded in the war against Russia. (3) Boguslaw, Prince Radziwill, son of Prince James and Sophie Elizabeth, margravine of Brandenburg, was governor in Prussia, 1657–69, and rendered important services in endowments to universities and schools. (4) Charles, Prince Radziwill, palatine of Wilna and grand-commander of Lithuania: b. 1734; d. 1790. He was the enemy of Czartoryski and the Russians, and an adherent of the Saxon party. He was an ardent supporter of the Confederation of Bar, and was several times exiled. For three years he was a member of the constituent diet at Warsaw. Consult ‘Die historische Stellung des Hauses Radziwill’ (1892).

Rae, rā, **John,** Scottish explorer: b. near Stromness, Orkney Islands, 30 Sept. 1813; d. London 22 July 1893. He studied medicine at Edinburgh, became surgeon in the Hudson's Bay Company's service in 1833, and from 1835 till 1845 was the company's resident surgeon at Moose Fort. In 1846–7 he made his first exploring expedition, covering 700 miles of the northern coast of America. He then went to London, and in 1848–9 accompanied Sir John Richardson in his Franklin search in the Mackenzie and Coppermine region. He conducted two expeditions in 1851, during the first of which he explored a large part of the coast of Wollaston Land. During the second he traveled a distance of over 5,000 miles in eight months, and explored much of the coast of Victoria Land. In 1853–4 he again conducted an expedition, and discovered the first traces of Franklin's fate, for which the party received the government grant of £10,000. He also proved King William's Land to be an island. He published ‘Narrative of an Expedition to the Shores of the Arctic Sea in 1846–47’ (1850).

Rae, W. Fraser, English author: b. 1835; d. 22 Jan. 1905. He was educated at Heidelberg and was admitted to the bar in 1861. Among his works are ‘Newfoundland to Manitoba’ (1881); ‘Facts about Manitoba’ (1882); ‘Miss Bayle's Romance,’ a novel (1887); ‘An American Duchess’ (1891); ‘Egypt To-day’ (1892); ‘Biography of Sheridan’ (1896).

Raeburn, rā'bėrn, **Sir Henry,** Scottish painter: b. Stockbridge, near Edinburgh, 4 March 1756; d. there 8 July 1823. He was left an orphan at an early age, and was apprenticed to a goldsmith, who, perceiving his talent for drawing, encouraged him in his ambition to be an artist. The favorite portrait painter in Edinburgh at that time was David Martin, who was the only instructor Raeburn ever had. He formed his style, however, by copying in color, mezzotints from the paintings of Sir Joshua Reynolds, and while he learned the chiaroscuro of that master he never attained his almost Italian richness and solidity of coloring. His drawing was correct, but unfortunately acting under the idea that a portrait was to be viewed at some distance above the level of the eye, he foreshortened the forehead and brought forward the nostrils and lower jaw. Thus Sir Walter Scott complained that his portrait by this artist caused him to look "clownish and jolterheaded." Acting on the advice of Reynolds, Raeburn spent two studious years in Italy (1785–7) which resulted in a marked improvement in his coloring, which had previously been thin and undecided. Wilkie actually wrote from Spain that the execution of Velasquez reminded him of Raeburn. His ‘Portrait of Mr. William Forsyth’ in the New York Metropolitan Museum is a fair specimen of his style and there are two pictures of his in the Lenox Library. Another fine portrait may be seen in the Art Museum, Worcester, Mass. He confined his serious artistic efforts entirely to portraits and painted every eminent Edinburgh man of his day.

Raff, răf, **Joseph Joachim**, Swiss composer: b. Lachen, Switzerland, 27 May 1822; d. Frankfort-on-the-Main 24 June 1882. He was educated at Wiesenstetten in Würtemberg and at the Jesuit Lyceum in Schwyz, and gained the notice of Mendelssohn and Liszt. In 1850 he removed to Weimar in order to be near Liszt, and his opera 'König Alfred' was shortly afterward produced at the Court Theatre there with great success. In 1877 he was appointed director of the Conservatoire at Frankfort, a position he occupied until his death. He was an indefatigable worker, his compositions numbering over 200, and his reputation rests chiefly upon his symphonies, among which are: 'Im Walde'; 'Lenore'; 'An das Vaterland'; etc. He was also very successful as a song-writer, and a notable composer of instrumental pieces, but his three operas were less successful. Though not confining himself to any one style of composition he was a supporter of the Wagner school.

Raffaello, rä-fä-ĕl'lō. See RAPHAEL.

Raf'fia. See FIBRE.

Raf'finose, the name given a plant sugar derived from the particular species of eucalyptus trees growing in Tasmania.

Raffles, răf'lz, **SIR Thomas Stamford**, English colonial administrator: b. at sea, off Point Morant, Jamaica, 5 July 1781; d. Highwood, near London, England, 4 July 1826. He was employed in the East India House as a clerk when 14, soon attracted attention by his ability and in 1805 was appointed assistant secretary at Penang. He mastered the Malay language while on the voyage and in 1807 was appointed secretary and registrar of the recorder's court. He visited Malacca in 1808 and in 1810 went to Calcutta where he met Lord Minto, the governor-general, and by his advice the expedition against Batavia was fitted out in 1811. He accompanied Lord Minto to Java in that year and after its capture from the Dutch became its lieutenant-governor, an office which he held for five years. His administration was eminently wise and successful; he retained the Dutch colonial laws, but abolished forced labor and instituted marked improvements in taxation and the administration of justice. He returned to England in 1816 when the island was given up to the Dutch, was knighted and commissioned by the prince regent to proceed to Holland to confer with its king in regard to the government of Java. In 1818 he was appointed governor of Benckulen in Sumatra, where he found many abuses existing. He abolished slavery, reorganized the government of the colony, founded schools, and otherwise greatly improved the condition of the island. He explored with Joseph Arnold the interior of the island and discovered the great fungus named in their honor *Rafflesia Arnoldi*. Ill health compelled his return to England in 1824 and on the voyage the ship caught fire, destroying his natural history collection, manuscripts, drawings and notes valued at $100,000. He held no further public office. He published: 'History of Java' (1817); and 'Malayan Miscellanies' (1820–2). Consult: Lady Raffles, 'Memoir of Sir T. S. Raffles' (1830); Egerton, 'Sir Stamford Raffles' in 'Builders of Great Britain' series.

Raffle'sia, an East Indian genus of parasitic plants, reduced to apetalous diœcious flowers, and named after Sir Stamford Raffles, the discoverer. *R. Arnoldi* was the first species discovered, in Sumatra. It is a gigantic flower, springing from the roots or stems of *Vitis* (*cissus*), three feet in diameter, and consisting of a globular central cup, containing either the ovary, or the numerous stamens, crowned by a ring, and the five-lobed calyx, fleshy, and flesh-colored, blotched with pink and yellow inside, and with brownish or bluish scales exteriorly. The whole flower sometimes weighs 15 pounds. It remains expanded for a few days only, and then decays, emitting a putrid odor that attracts carrion-loving flies, which probably assist in cross-fertilization. The fruit is a brown, rough surfaced nut, holding innumerable seeds. Certain Javanese species are valued there as powerful styptics.

Rafinesque-Schmaltz, rä-fē-nĕsk' smältz, **Constantine Samuel**, American botanist: b. Galatz, Turkey, 1784; d. Philadelphia, Pa., 18 Sept. 1842. He was of French-German parentage and was sent to America in 1802 where he made botanical investigations in Pennsylvania and Delaware and in 1805 returned to Turkey with botanical specimens. While sailing for the United States in 1815 he was shipwrecked off the coast of Long Island and lost his collection of 20 years. He settled permanently in the United States in 1815, and was made professor of botany in Transylvania University, Lexington, Ky., in 1818. Later, after lecturing in various places, he removed to Philadelphia. He was a man of wide learning, but his work is in many instances rendered confusing by his insatiate desire for novelties, and though evincing keen insight is frequently inexact. His publications include: 'Ancient History, or Annals of Kentucky' (1824); 'Medical Flora, etc., of the United States' (1828–30); 'A Life of Travels and Researches in North America and South Europe' (1836); 'Pleasures and Duties of Wealth' (1840); etc.

Raft, a floating platform, usually composed of wooden logs or planks, fastened together by nails, spikes or cordage, and used either as a vehicle of travel and for the carriage of goods, or more generally for the purpose of transporting by river, lake or sea the materials composing the raft from the place of its construction to a market for sale. In all probability the raft was the first human method of travel on water, next to floating on a large branch or tree-trunk, the use of which would naturally suggest the raft, just as a raft, with sail of skin or other material raised to catch the wind, would suggest the first rude sail boat or ship. Rafts have been in use in all historic ages, and doubtless far back in the prehistoric period, but they reached their most general use after the settlement of North America, when the vast forests were being cleared by settlers, and the raft offered almost the only method by which the pioneer on the Ohio or Mississippi could reach the settlements on those rivers, dispose of his surplus products, and buy some of the comforts and perhaps luxuries to be obtained in the towns. The steamboat has almost entirely done away with the raft as a means of travel, but rafting is still the chief method of conveying the lumber product of northwestern forests to market, and immense rafts are sometimes sent by sea from Maine to New York or Boston. On the Pacific coast also the rafting business is most extensive. In the fall of 1902, a monster raft 700 feet long, 53 feet wide, 12 feet from the water's edge to the top, and drawing 22½ feet of water was safely towed 700 miles from Columbia River to San Francisco. The logs were 120 feet long, and from 12 to 20 inches in diameter, and there were in all 7,000 pieces, valued at $60,000. The construction of a raft of this size is a vast undertaking. A great «cradle» of heavy timbers is built on a slough connected with the Columbia River. A row of piling is driven in deep water, and the frame of the cradle floats up and down on the row of piling, and is held in place by it. A large scow with a derrick is anchored beside the cradle. Log-booms or small rafts are towed to it, and the logs are lifted by the derrick into the cradle, where they are fastened with chains and cables, from 80 to 100 tons of chain being used on one raft. When the raft is finished the keys that held the parts of the cradle together are drawn, the side of the cradle is pulled away, and the raft floats out on the water. Tugboats draw it into and down the Columbia, and out to sea on its voyage to the Golden Gate.

Fire-rafts have been used in ancient and modern wars to destroy an enemy's vessels, but since navies have been built of iron and steel, the fire-raft is becoming obsolete.

Ragatz, rä'gäts, Switzerland, a fashionable Spa in the province of St. Gall on the Tamina, celebrated for its hot springs, mineral waters, and scenery. See PFEFFERS.

Ragged Robin. See LYCHNIS.

Ragged Schools, a name given in Great Britain to those institutions supported by voluntary contributions for the education of neglected children and the consequent prevention of juvenile crime. The idea of forming such schools was due to a Portsmouth cobbler, John Pounds, who about 1819 began to take in the ragged children of the district in which he lived and teach them while he was at work. This he continued till his death in 1839. The success of the plan caused a number of more influential persons to take the matter up, and in 1838 a ragged Sunday-school was opened in London. In 1841 the first feeding-school, in which the children are not only educated but kept and fed for the day, was started in Aberdeen. What gave a greater impetus than anything else to the ragged school scheme was Dr. Guthrie's 'Plea for Ragged Schools,' published in 1847. It had an immense circulation, and was followed by the extension of the system to every considerable town in the kingdom. The name ragged schools was first adopted in 1844. Owing to the education acts, and especially the introduction of compulsory school attendance and abolition of fees, many of these schools were absorbed by the school-boards, and altogether they may be said to be a thing of the past.

Raghuvaṁśa, rā-g-hoo-vän'shạ, one of the two epics of the Sanskrit poet Kâlidâsa (q.v.). Its subject is the legendary history of the solar kings, or kings descended from the sun. See SANSKRIT LANGUAGE AND LITERATURE.

Ragie, a grain. See ELEUSINE.

Rag'lan, Fitzroy James Henry Somerset, LORD: b. 30 Sept. 1788; d. Sebastopol 28 June 1855. In 1804 he entered the army and in 1807 served on Wellington's staff in the expedition to Copenhagen, while throughout the Peninsular campaign he served as military secretary. In 1814 he acted for a short time as secretary to the embassy at Paris, and from January to March 1815 was minister plenipotentiary there. At Waterloo he lost his right arm. From 1819 to 1852 he was military secretary to the Duke of Wellington, in 1852 became master-general of the ordnance and in October of that year entered the House of Peers as Baron Raglan. He was commander of the English forces in the Crimean war, where he suffered much from the early failures of the campaign and from the hostile criticism of the inefficient commissariat arrangements. Consult Kinglake, 'Invasion of the Crimea.'

Ragman Rolls, documents containing a record of the acts of allegiance extorted by Edward I. of England from the nobility and gentry of Scotland in 1291–2 and 1296. The document was delivered back to the Scotch along with other records and muniments in 1329 in terms of the Peace of Northampton when the independence of Scotland was formally acknowledged. It is now deposited in the British Record Office.

Ragnarök, räg"nạ-rēk', in Scandinavian mythology, the day of doom when the present world will be annihilated, to be reconstructed on an imperishable basis. The title of the concluding portion of Wagner's great operatic trilogy 'Götterdämmerung' is a translation of this word. In that work is depicted the downfall of Woden and the gods and the triumph of perfect human love. William Morris also treats this subject in his 'Sigurd the Volsung.' 'Ragnarök' is the title of a novel by Ignatius Donnelly.

Ragout, rạ-goo', a French dish prepared of meat or fish stewed with vegetables, and highly seasoned.

Ragozin, rä-gō'zēn, **Zenäide Alexeievna**, Russian-American writer: b. Russia 1835. She traveled widely in Europe and in 1874 came to the United States. She is a member of the leading American and European literary societies, and has achieved a wide reputation as an author. Her most important books are: 'The Story of Chaldea' (1886); 'The Story of Assyria' (1887); 'The Story of Media, Babylon, and Persia' (1888); 'History of the World'; 'Siegfried, the Hero of the Netherlands' (1898); 'Roland, the Paladin of France' (1899); 'Salammbo, the Maid of Carthage' (1899).

Rags, though valueless for most purposes, are yet of great importance in the arts, particularly in paper making. Woolen rags of a loose texture, and not too much worn, are unraveled by means of machinery, and mixed up with good wool, to form what is known as «shoddy,» with which cheap woolen goods are made. Large quantities of rags are imported to the United States from Great Britain and the continent of Europe.

Ragueneau, räg-nō, **Paul**, French missionary and explorer: b. Paris 1605; d. there 3 Sept. 1680. He joined the Jesuit order, and went to

Canada in 1636 to work among the Indians, first visiting the Hurons. In 1640 he made an unsuccessful attempt to secure the release of French prisoners from the hostile Iroquois. Becoming the head of the Jesuit missions in Canada in 1650, he brought the remnant of the Hurons to Quebec to escape the Iroquois. On a visit to the Onondaga tribe of Iroquois he nearly lost his life. His chief success was with the Hurons, with whom he labored until 1666, when he returned to France and acted as agent for the Canadian missions. He wrote 'Vie de la Mère St. Augustine, religieuse Hospitalière de Quebec en la Nouvelle France' (1672); 'Relacion de ce qui s'est passé de plus remarquables ès Missions des Pères de la Compagnie en la Nouvelle France' (1647–57), the latter work covering the years 1645–52 and 1656–7. Consult: Parkman, 'The Jesuits of North America' (1867); 'The Jesuit Relations' (1896–1901).

Raguet, rä-gā', **Condy,** American political economist: b. Philadelphia, Pa., 28 Jan. 1784; d. there 22 March 1842. He was educated at the University of Pennsylvania, studied law, and later entered upon a commercial career. He went to Santo Domingo in 1804 as supercargo on a vessel and made a second voyage to that island in 1805. In 1806 he went into business on his own account and was eminently successful, amassing an immense fortune and playing an important part in the commercial affairs of the day. In 1812 he was active in providing for the defense of Philadelphia against the expected attack of the British fleet, and in 1815 was elected to the State legislature where he subsequently served in both houses. He was appointed United States consul at Rio Janeiro in 1822 and in 1825 became *chargé d'affaires* to Brazil, an office he occupied until 1827. After his return to the United States he edited several journals devoted to free-trade doctrines, among them 'The Free Trade Advocate' in 1829; 'Examiner' in 1834–5; 'The Financial Register' in 1837–9; he also published two small volumes relating to Santo Domingo; 'Principles of Free Trade' (1835); 'On Currency and Banking' (1839); etc.

Ragusa, rä-goo'sä (Slavic, DUBROVNIK), a seaport town of southern Dalmatia, Austria-Hungary, on a peninsula projecting into the Adriatic. It lies at the foot and on the slopes of Monte San Sergio and its streets rise in terraces from the Corso, the principal thoroughfare, which traverses the centre of the city. There are old walls flanked with towers and a fort erected during the French occupation in the beginning of the 19th century. Among the notable public buildings are the cathedral dating from the first years of the 18th century; the new Greek church; the older churches of the Franciscans, Dominicans, and Jesuits; the townhall, anciently the governmental palace, completed in the early part of the 15th century after nearly a hundred years in building, and forming a magnificent example of the Gothic-Venetian style; and the Dogona, of the same architectural type. The industrial interests of the town comprise chiefly manufactures of silk, leather, and liqueurs. The coasting trade is important, but owing to the shallowness of the harbor, centres chiefly at Gravosa, some four miles to the north. The population in 1910 was 14,500. Ragusa was founded in the 7th century of our era by refugees from the ancient Epidaurus, now known as Ragusa Vecchia, when that city, whose origin goes back to the 6th century before Christ, was destroyed by the Slavs. Ruled in turn by the Byzantines, the Venetians and the Hungarians, it acquired in the 13th and 14th centuries, through trade and unscrupulous diplomacy, lordship over a territory of some 750 square miles and maintained its existence as an aristocratic republic, paying tribute, after 1440, to the Turks. The prosperity of the town was undermined by several epidemics in the 16th century and by repeated earthquakes of which that of 1667 was the most disastrous. In 1806 Ragusa was occupied by the French, two years later the republican form of government was abolished, and in 1809, with the rest of Dalmatia, it was annexed to the Illyrian kingdom. In 1814 it passed to Austria. The see of Ragusa was founded in 980, and from 1121 to 1831 it was the seat of a Roman-Catholic archbishop. So well known were its trading vessels in former times that our word *argosy* is derived from the name of this port.

Ragusa, a town of Sicily, in the province of Syracuse, on the mountain stream Erminio, some 30 miles west-southwest of Syracuse. It has considerable manufactures of cotton and other textiles, oil, furniture, and asphalt and carries on an important trade in corn and wine. It comprises two communities, Ragusa proper with a population of about 32,000, and Ragusa Inferiore with 8,550 inhabitants. Ragusa is supposed to be the ancient Hybla Heræa.

Rag'wort, any of various composite weeds of the genus *Senecio,* now common in all parts of the world. These coarse, yellow-flowered, pubescent plants are allied to the thistles, and some of the score of American species are known as squaw-weed, ragwort, and butterweed, and in England as groundsel. See SENECIO.

Rahl, räl, **Karl,** Austrian painter: b. Vienna 13 Aug. 1812; d. there 9 July 1865. At 19 he won a prize at the Vienna Academy and then started on his first tour among the art centres of Germany, Hungary, and Italy. He made his home in the last named country from 1836 to 1843, studying especially the painters of the Venetian and Roman school, from whom he derived the grandeur of conception and noble coloring for which his works are distinguished. In 1846, after two years' residence as a portrait painter in Vienna, he resumed his travels and practised his art with success and profit in Holstein, Paris, Rome, Copenhagen, and Munich. Among his historical paintings of this first period are 'The Finding of Manfred's Body'; 'Manfred's Entrance into Lucera'; 'The Catacombs during the Persecution' (in the Hamburg Gallery and a replica in the Berlin National Gallery). He was appointed professor in the Berlin Art Academy in 1850, but his political opinions were extreme and violent and he was compelled to leave the city. The private school which he thereupon opened became the most important seminary of painting in Austria. He meanwhile applied himself to much decorative work, as is testified by the painted façade and vestibule of the church in the Old Meat Market at Vienna, the four compositions from the Greek heroic age, and the 'Four Elements' in the palace of Baron Sina. In 1864 he painted in the Museum of Arms a series of allegorical figures of heroic size. To this period belong his fresco, 'A Maid from Foreign Lands'; and the designs for a ball-room in Oldenburg Castle and 'Incidents of the Argonautic Expedition.' His last works consisted of designs for the decoration of the New Opera House at Vienna. These were executed by his pupils after his death. He unites in his pictures the rich coloring of Rubens and Titian with a harmony of grouping monumental in its impressiveness. Yet his handling of form inclines to coarseness and exaggeration. Among the most eminent of his pupils were Bitterlich, Eisenmenger, Lotz, Griepenkert, Gaul, and Than. Consult: George-Mayer, 'Erinnerung von Karl Rahl' (1882).

Ráhu, rä'hoo, in Indian mythology, the demon who is imagined to be the cause of the eclipses of sun and moon. Rahu, having stolen of the nectar of immortality, was caught and beheaded before he swallowed the divine stuff. The head thus became immortal, and ever afterward followed the sun and moon. When it occasionally caught them an eclipse resulted.

Rahway, râ'wā, N. J., city, in Union County; on the Rahway River, and on the Pennsylvania railroad; about 20 miles southwest of New York city. It is a residential city, and its clean, well-laid-out streets, its parks, and fine residences make it an attractive suburb. It has considerable manufacturing interests; the chief establishments are chemical works, printing houses, shirt factories, lace curtain factories, felt mills, steel works, carriage and music box factories. There is a large trade in manufactured articles, fruit, and vegetables. It has a high school, public and parish schools and a library, which has about 20,000 volumes. Pop. (1910) 9,337.

Rai Bareli, rī bä-rā'le, India, (1) headquarters of a district of the same name, on the banks of the Sai, 48 miles southeast of Lucknow. It has a spacious fort, a magnificent palace, four fine mosques, and the tomb of Nawab Jahan Khán. Pop. 18,798. (2) The district of Rai Bareli forms a part of the Lucknow division, and has an area of 1,751 square miles. Pop. about 1,100,000.

Raiatea, rī-ä-tä'ä, Polynesia, an island of the Society group, northwest of Tahiti; area, 75 square miles. It is mountainous (3,400 feet), but fertile, and traversed by many streams. The chief products are cotton and copra. Pop. (Protestant) 2,300.

Raibolini, rī-bō-lē'nē, **Francesco**. See Francia, Francesco.

Raiffeisen, rīf'ī-zěn, **Friedrich Wilhelm**, German economist: b. Hamm, near Coblenz, Germany, 30 March 1818; d. 11 March 1888. He entered the army in 1835, but was compelled by ill health to withdraw and then entered the civil service. During the agricultural troubles of 1846–7 he perceived the difficulty with which the small landholder procured credit and he conceived the idea of establishing small mutual credit associations which freed the farmer from the exorbitant rates of the usurers. His first efforts were at Heddersdorf and Wyerbusch and he then proceeded to extend the operation of the plan throughout Germany. In 1866 he broke down from overwork and retired for a time from public service. In 1878 he founded the 'Landwirtschaftliches Genossenschaftsblatt' at Neuwied. He lived to see his plan in successful operation in Germany, Austria, Switzerland, and Italy. He wrote: 'Instruktion zur Geschäfts- und Buchführung der Darlehnskassenvereine' (1869); 'Kurze Anleitung zur Gründung von Darlehnskassenvereinen' (1888); etc.

Raikes, rāks, **Robert**, English founder of Sunday schools: b. Gloucester, England, 14 Sept. 1735; d. there 5 April 1811. He succeeded to his father's business as editor and publisher of the Gloucester 'Journal' in 1757 and used its influence in exposing certain prison abuses in his native town. In 1781 he founded several Sunday schools which he engaged needy women to teach at a shilling a day, and succeeded in inducing the attendance of the children of the city. In 1803, largely through his efforts, the Sunday School Union was founded. Consult: Lives by Gregory (1877), and Eastman (1880); Harris, 'Robert Raikes: The Man and his Work' (1899). See Sunday Schools.

Rail Sections as Engineering Structures and Their Correlations to Equipment and Operation of Railroads. It is what a rail section can do, its combined stability, efficiency, and capacity with the equipment for carrying the loads, which determine its status and relative importance as an engineering structure. A rail section is heavy at the present time, of which sufficient for a mile of track equals or weighs more than the passing locomotive.

The installation of the railroads in the United States from 1826 to 1833 was usually with strap-iron rails, forming the bearing surface for the wheel treads, and guide to the flanges, laid on wooden or stone stringers as the girders.

The engines were of the four-wheel type, short wheel bases, and rode unsteadily over the light tracks. The driving-wheel loads, at first intended not to exceed 1,700 pounds, when increased to 4,000 pounds injured the light structures, at speeds of 10 to 15 miles per hour.

John B. Jervis, chief engineer of the Delaware & Hudson Canal Company's railroad, completed in 1829 the superstructure of strap-iron rails on wooden stringers, designed for the transportation of coal by steam-engines, from the mines to the canal at Honesdale, Pa.

Three engines were constructed in England, under directions not to exceed 1½ gross tons per wheel, but were heavier as built. The "Stourbridge Lion," 8 Aug. 1829, made only a short trial trip, and proved too heavy for the structure, and locomotives as motive power were abandoned.

The track proved adequate for the transportation of about 1,000,000 tons of coal annually, for several years, under the designed static wheel loads.

Mr. Jervis was the chief engineer of the Mohawk and Hudson Railroad in 1830, and 9 Aug. 1831 made the successful trial trip with the locomotive De Witt Clinton and passenger train. The superstructure was strap-iron rails 2½ inches wide, 9/16 of an inch thick, the upper corners rounded to a width of 1⅞ inches, and

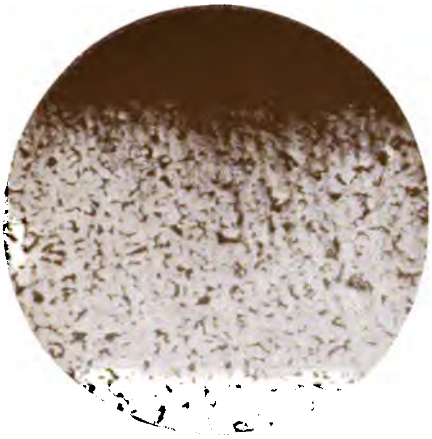

Fig. 6.—BARROW STEEL, 1868.
NON-GRANULAR.

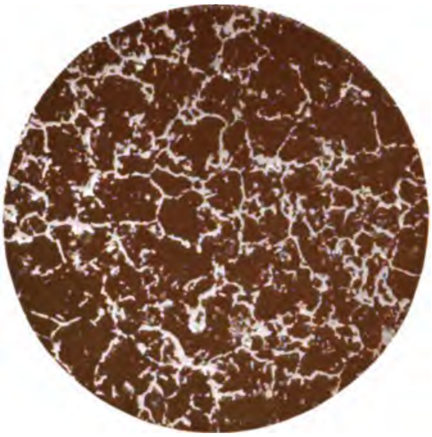

Fig. 7.—100-LB. STEEL, 1892.
GRANULAR. GOOD.

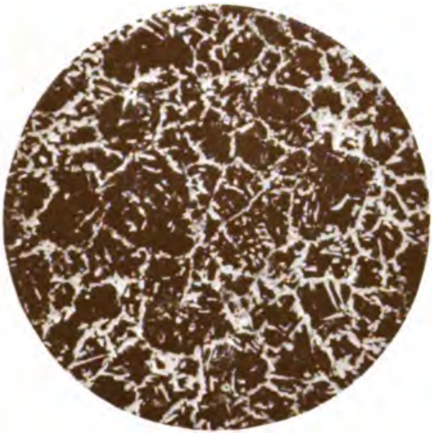

Fig. 8.—80-LB. STEEL. COARSE.
GRANULAR, 1902.

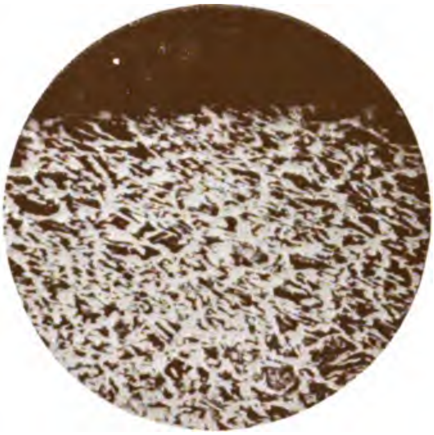

Fig. 9.—SAME STEEL AS NO. 8.
CRUSHED IN THE BEARING SURFACE.

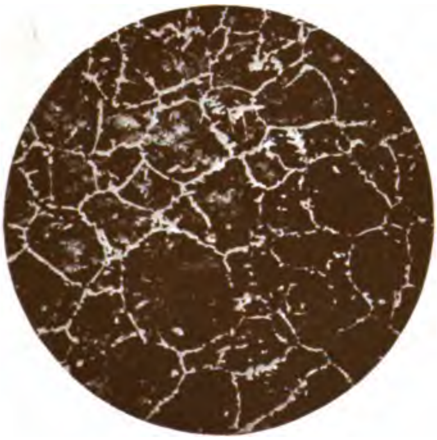

Fig. 10.—100-LB. STEEL.
COARSE GRANULAR, 1900.

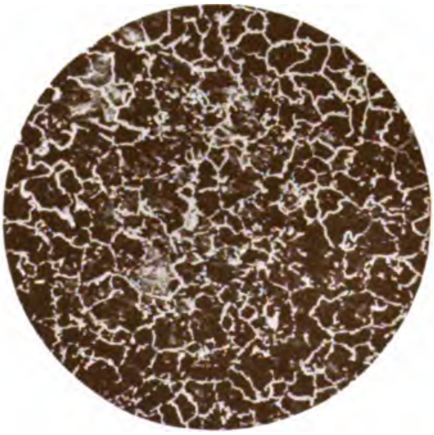

Fig. 11.—80-LB. STEEL. GRANULAR.
GOOD, 1902.

laid central upon 6 x 6-inch pine stringers, supported by stone blocks, each of two cubic feet, spaced three-feet centres, and set upon broken stone foundations, for inflexible supports as for buildings. This theory Jervis discarded in 1832 for that of the elastic roadbed.

The De Witt Clinton weighed 6,758½ pounds, and the John Bull, made by Robert Stephenson & Company, Newcastle-on-Tyne, England, weighed 12,742 pounds, of which 8,745 pounds were upon the pair of driving-wheels, which proved heavy for the superstructure and rode unsteadily over the track, and seldom used as received.

Mr. Jervis, in 1832, designed his four-wheel «leading and guiding truck,» and substituted it for the front pair of carrying wheels of the engine, which extended the wheel-base and gave it lateral and vertical flexibility for ease of locomotion.

The truck, supporting the front of the engine, and the one pair of drivers the rear, subdivided the total load for distribution, and used a part to stiffen and strengthen the track for the driving-wheel loads, which was the inception of this valuable principle of American practice. A second pair of drivers was added, for greater adhesion, making the type of the American locomotive, which could now cross the mountain divides without inclined planes, a requirement for railroad extension and operation.

The prototype of the present tee sections, to be rolled as one piece and spiked directly to the wooden cross-ties or stone blocks, was designed by Robert L. Stevens in 1830, and laid on the Camden & Amboy Railroad in 1832. It was rolled in Wales, in 16-feet lengths, fished by 6-inch riveted two-hole plates, was 3½ inches high, 3¼ inches base, head 2⅛ inches wide, and weighed 39 9/16 pounds per yard; therefore was expensive, and the principles of construction not copied generally until after 1840, when it had demonstrated its value.

The two problems, evolution of the locomotive and of the rail section, were being solved at the same time, an improvement in either aiding the other, owing to the correlations which exist between them.

The strap-iron rails served to develop practical locomotion only, as about 4,000 pounds static driving-wheel loads were their limit, the spikes drawing or breaking, and failed to hold the iron to the wooden or stone stringers, as mechanical structures, and frequently the facing ends of the rails («snake heads») sprang up above the centre of the following wheel and curled through the floor of the car, impaling passengers in their seats.

Sundry types of sections for iron rails, including Birkinshaw's «fish-bellied,» and the Clarance pattern, set in chairs, compound forms of two or three pieces, were tried with the strap-iron rails, and by or before 1844 the most efficient iron tee sections became the principal reliance for service until 1863, the advent of Bessemer steel.

The compound rails failed mechanically after a short use. The best quality of iron rails, in light sections, rendered some years of service, until the static driving-wheel loads began to exceed 7,000 pounds. Before they had reached 10,000 pounds, lamination and exfoliation of the iron in the bearing surface were rapid, owing to its limited and inadequate physical properties of cubic elasticity.

The pile of iron for the rail was formed of several slabs or pieces, put into a furnace and brought up to a welding heat, with the expectation that complete union would occur between all of the pieces in rolling. This did not take place, and the cinder which was in each bar rolled out more as a bundle of fibres in the section, preventing the formation of a solid homogeneous structure. The linear elasticity was sufficient as a girder, but deficient in cubic elasticity for the metal in the bearing surface.

The manufacture and use of heavier and stiffer sections of iron, for smoother and more stable tracks, caused such rapid wear of the rails that many companies returned to the use of lighter sections. This was a check to the extension and development of transportation for the country.

The introduction, in 1863, of light rails of Bessemer steel, a product more homogeneous and solid than iron, furnished a metal which, in the bearing surface, wore well, exceeding the life of 10 to 15 iron rails. This in a few years reduced operating expenses and enabled the extension of railway systems to new territory.

The cost of the steel limited the rails to light and limber sections. They were inefficient as engineering structures, and did not permit the desired enlargement of the locomotives to overcome the resistance of heavier trains, and meet the demands and requirements of transportation.

The maximum static load per driving-wheel in 1876 was about 13,000 pounds for some of the largest passenger engines, but three times greater than it was upon the strap-iron rails.

I invented and constructed my Dynagraph in 1874, to measure train resistance, and observed upon the Lake Shore & Michigan Southern, Baltimore & Ohio, Philadelphia, Wilmington & Baltimore, Boston & Albany, and the New York Central & Hudson River railroads that on new rails well surfaced the resistance was less than upon worn rails with low joints, the topographical conditions being the same.

A test was made of a passenger train, in 1878, on the New York Central & Hudson River Railroad, of 9 cars, 300 tons weight, at 51 to 52 miles per hour; the resistance was 11½ to 12 pounds per ton, only two thirds of that estimated by the English formula of Clarke. These were valuable facts to establish, not only as to the amount of the train resistance, but to one of its elements, for on the smoother track the resistance for every wheel was reduced, by rolling forward with less vertical undulations and shocks.

A sphere moving over a perfect plane in a straight line, irrespective of speed, theoretically would not do work for or against gravity, applies in principle to a moving car-body or wheels on the rails. Tracks of true planes on steam railroads are not expected to be realized, yet it was necessary to investigate their condition and measure the undulations on the light steel rails, to ascertain what was required to add to their efficiency and commercial value as engineering structures. The investigations of the condition of the track were made by the complete instruments I designed in 1880 for my Track Indicator. A special 6-wheel truck, of 11-foot wheel base, was made, to carry one end of the 50-foot car which contains the recording mechanism. The total load upon the truck is 19 tons, and the outer wheels act as the datum plane, while the middle wheels indicate the surface undulations of each line of rails, upon the moving band of paper, on a scale of one inch per 50 feet of track which is sufficient to show the detail of each rail. The vertical scale is full size.

The theory is, that if the running surface of the rail in its general depression under the truck is smooth, the recording pen would draw a straight line; if not, its deviation.

The gauge of track, speed, and distance, are measured, while the sections, mile posts, and stations, are located as they are passed.

The undulations are summed up automatically into feet and inches per mile, which furnish the data for the condensed diagrams, and show on a scale of 1/4 of an inch per mile the comparative condition of the track. These were commenced in 1881, and annually repeated exhibit the reduction in undulations, by the transition from the light and limber sections to the heavier and stiffer rails, as engineering structures, and also that the static driving wheel loads have nearly doubled in the meantime.

Paint is ejected automatically on the rails, for the trackmen, where the deflections exceed 1/8 of an inch.

The inspections of the track on the early steel sections indicated that the rails on all the different railroads had characteristic permanent sets, which proved that the mechanical elements of stiffness of the 4 or 4 1/2-inch sections were insufficient for the wheel loads. The trackmen were unable to maintain the track and prevent sets taking place in the rails, and rapid cutting of the cross-ties under the rail seats. The joints were low, the facing ends of the rails cut out, which gave shocks to every passing wheel, while the undulations under the wheel loads of the Track Indicator recorded from 6 to 12 feet per mile.

The original and condensed diagrams of over 10,000 miles of track were measurements and new data, to study the action and requirements of a section in the track, and in 1883 I designed the pioneer 5-inch 80-pound steel rail, for the New York Central & Hudson River Railroad, and in 1884 commenced to replace their 4½-inch 65-pound rails. With 15 pounds or only 23 per cent more of metal, the section was increased in stiffness 60 per cent and in strength 40 per cent, and with a head 2 11/16 inches in width enforced the resultant of the passing wheel loads by their treads to hold the rails in a vertical position on the cross-ties, checking the rolling out and spreading of the gauge, which augmented the running stability of the equipment.

The 80-pound rails made a stiffer, stronger and smoother track than the former 65-pound and were soon followed by the Pennsylvania and the other railroad companies' adoption of 5-inch 80-pound or heavier sections.

The augmented 60 per cent in stiffness and 40 per cent in strength, with the advantageous correlations existing between them and the equipment, enabled nearly doubling the axle and total loads of the locomotive and cars on the same roadbed. It marks a distinct epoch in the progress of transportation.

Mr. William Buchanan, general superintendent of motive power, New York Central & Hudson River Railroad, designed his famous locomotive, No. 870, in 1889, with 40,000 pounds upon the engine truck, 80,000 pounds upon two pair of driving wheel axles, and 80,000 pounds upon the tender when loaded with coal and water, which made the first 100-ton locomotive. These weights did not disturb the track on the stiffer rails as the lighter axle loads had upon the former limber rails. On November 30, 1891, the Empire State Express was installed, the fastest long distance train ever attempted, which still maintains its prestige, as a demonstration and educator of practical fast speeds on stable track.

The running time from New York to Buffalo, 440 miles, was 8 1/2 hours, including 3 stops, 2 changes of locomotives, and 28 slow downs. In 1895 the schedule time was reduced 15 minutes. The achievement was of interest to the railroad world as an accomplishment of what had been considered previously impossible. The practical effect of the stiff rails has been the construction of larger and more powerful locomotives and an increase of speed on railroads, as shown by statistics. The Twentieth Century Limited, on the New York Central & Hudson River Railroad, and the Pennsylvania Special on the Pennsylvania Railroad, are now running from New York to Chicago and return each way in 18 hours.

The mechanical properties of stiffness and strength of a section are secured in the design for a given height and weight of metal by distributing as much of it in the head and base as far from the neutral axis for the longitudinal stresses as requisite for the relations of the bearing surface, guide and girder, denoted in Fig. 2.

The mechanical properties of different sections, are ascertained and compared by their respective moments of inertia and moments of resistance, and in the higher and heavier sections they increase in a faster ratio than the weight, and cost,— an engineering and economic advantage. See Table No. 1.

The different weights of the sections have from 40 to 45 per cent of the metal in the

TABLE NO. 1.

Weight of Section in lbs.	Height in inches.	Width of Head inches	Moment of Inertia 4th Power inches	Moment of Resistance cubic inches	Bending Moments carried per Section for 20,000 lbs. Unit Fiber Strains inch-pounds.
60	4.0	2 1-4	12.0	6.7	134,000
65	4.5	2 3-8	16.0	7.8	156,000
80	5.0	2 11-16	26.0	10.5	210,000
80	5 1-8	2 21-32	28.5	11.4	228,000
100	6.0	3.0	48.5	16.6	332,000

head, 37 to 40 in the base, and 20 to 23 in the web. The bearing surface is crowned with a radii of 12 or 14 inches, while the upper corner radii are 5/16 or 3/8 of an inch. The fishing angles of the head and base are 13 or 14 degrees, according to the design — the latter being the best to take up the wear of the splice bars. The web is joined to the head, in the best designs, by fillets of 1/2 inch radii.

The increased mechanical element of stiffness of rails lessens the deflections for a given load, while the strength reduces the unit fibre strains, therefore augments the capacity for larger bending moments and better distribution of the wheel effects to the cross-ties and ballast; but the wheel contact pressure intensity per square inch in the bearing surface is increased.

Standard sections of given weights, varying by increments of 5 pounds per yard, have been designed, with definite mechanical properties, and are manufactured as commercial products. My standards consist of 15 sections of 50 to 105 pounds per yard. There are three duplicate weights, but of different mechanical properties.

The 80- and 100-pound for main lines are in most general use, and the 65, 70, and 75 for branch lines, though the 80-pound will soon be a requisite. The New York Central & Hudson River Railroad commenced to lay my 6-inch 100-pound section in 1892, and that weight has become the standard for the Eastern trunk lines.

The A. S. C. E. standards are from 20 to 100 pounds per yard. The English standards for flat-bottom sections are of the same weights, for use in India.

"Bull Head" sections are standards for England.

The superstructure of the track, for American, English, French, and German steam railroads, is flexible, on an elastic roadbed as the foundation, and under the area of the wheel bases of the locomotives and cars to be loaded as uniformly as possible, by pressures which can be sustained, and their generated forces, until the total resistance equals their effects.

The ballast and roadbed are compressed from one fifth to one third of the total amount of the temporary subsidence of the rail, and the latter is affected for a depth of 12 to 20 feet, according to its material, construction, and stability.

The rails are loaded only by the rolling wheel contacts, which bend them downward under the wheels, as indicated in Fig. 1 — the positive bending moment — while in the wheel-spacing the flexure is upward — the negative bending moment; shearing stresses connecting the bending moments at the points of flexure.

The rail section therefore resolves and distributes its wheel-load effects by longitudinal components of stress, and produces compression in the metal above the neutral surface directly under the wheels, and below tension. Either side of the wheels in the spacing the stresses are reversed at the points of flexure, the wheel-space controlling the span of the bending rail more than that of the cross-ties. See Stremmatograph Test No. 257.

The strain in the metal of the rails is continuous for the entire wheel base of the locomotive, and not discontinuous per wheel. Comparisons for precision of the stresses under locomotives of the same or different types must include the total effects from all of the wheels as though distributed from their centres of gravity. See Test No. 257.

The tests of the unit fibre strains upon the same track show that reducing the wheel-spacing decreases the total bending moments, and distributes the load more favorably upon the foundation. This is confirmed in practice by the excellent results by the Ten-wheel, Pacific, and Consolidation types of engines.

Three Essential Principles of the Rail Section as an Engineering Structure.—First: The top as the bearing surface for the rolling wheel contacts.

Second: The side of the head, as the guide for the wheel flanges.

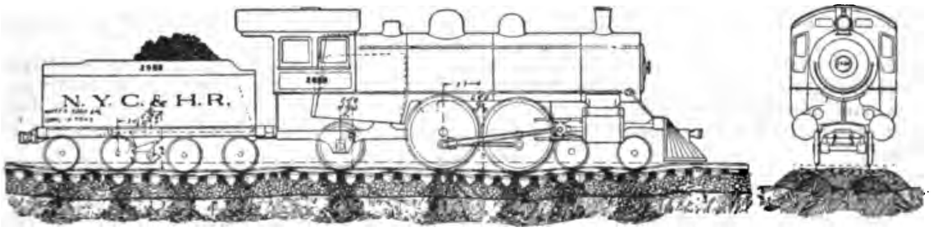

Fig. 1.— The broken line indicates the "Trackmen's Surface," while the surface of the rail under the driving wheels, the *Constrained Beam* in the General Depression. The cross-ties, ballast, and sub-grade are depressed decidedly under the specific deflections of the rails by the wheel contacts.

The positive bending moments under the wheels, and the negative constraining bending moments in the wheel spacing, with their respective fiber-strains, are indicated in the rails. The centers of gravity of the engine, locomotive, and tender are marked by a dot in their respective positions. Vertical scale of the General Depression is 24 times that of the locomotive.

The stiff rail section is the most conservative and useful member of the superstructure for this purpose, and advantage is taken of this fact in the construction of the American equipment, by distributing the total load on several wheels. The rails, cross-ties, and ballast, as illustrated by Fig. 1, are depressed from the trackmen's surface — represented by the broken line — 1/8 to 3/8 of an inch, to the loaded running surface in the general depression, by the wheel loads

Third: The entire section as a girder, to distribute the wheel-loads.

These are designated as bearing surface, guide, and girder, and illustrated by Fig. 2.

These three principles, embodied in a solid section, apply to limber or stiff rails, though the mechanical properties, as vertical stiffness and strength, will increase as the height and weight are augmented. See Table No. 1.

The numerous types of rail sections which have been designed, used, and sustained the service, since the installation of the railroads, are those only in which the bearing surface, guide, and girder have been fabricated in a solid piece.

The strap-iron rails on wooden or stone stringers, the compound rails of two or three pieces fastened together by rivets or bolts, all failed as engineering structures, from mechanical and metallurgical inefficiency, after short service, as the wheel-loads increased.

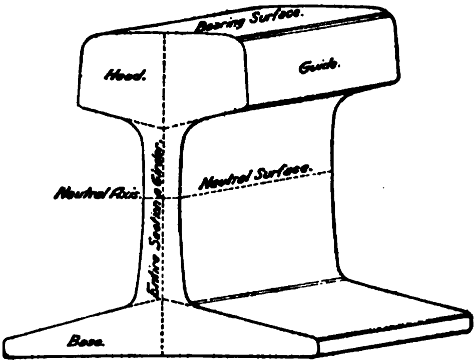

Fig. 2.— The Rail Section as an Engineering Structure of One Piece of Metal.

Physical Properties.—Sections of iron or steel have values as engineering structures according to their physical properties. The metal for the rail as the bearing surface, guide, and girder has therefore three requisite, dissimilar, but not inconsistent, functions to unite and serve by its physical properties.

First: The metal of the bearing surface under the rolling wheel contacts, in distributing its loads, resists deformation, shear and wear, principally by its mass hardness and cubic elasticity, and requires homogeneity, solidity, and malleability.

Second: The metal of the side of the head, as the guide for the passing wheel flange, resists abrasion best by its cell hardness and tenacity.

Third: The metal as the girder to distribute the wheel-loads, should provide for the bending moments, and consequent unit fibre strains, by less than one half of its elastic limits of linear elasticity.

The utility and durability of a rail section depend, therefore, upon the mechanical properties of its design, in combination with the physical properties of the material out of which it is fabricated.

Bearing Surface.—The functions of the section as a girder, for safety in distributing the wheel-loads, control the physical properties of the metal which may be provided for the bearing surface and guide. See Fig. 2.

The head of the rail must have sufficient width to form the bearing surface, to enable the metal, by its mass hardness, to receive and sustain the wheel-loads without rapid wear or decided permanent set as they roll over the rail. The metal in both the wheel and the bearing surface of the rail resists the intensity of pressure per square inch by its cubic elasticity, and to be efficient requires homogeneous solid metal.

The rails from the upper parts of the ingots often have an exterior layer of metal of normal chemical composition, but, owing to liquation in the fluid metal of the ingot, encloses a core of harder, more fusible steel, containing occluded gases affecting the homogeneity and solidity of the rail-head.

Such steel cannot sustain the heavy contact pressures of 100,000 pounds to 200,000 pounds or more per square inch, without flow or distortion, as its limits of cubic elasticity are reduced by the unsound metal.

Slight porosity in the steel, from entangled gas in the columnar structure one eighth of an inch under the bearing surface, develops into a defect under the traffic and a small piece becomes loosened and flakes from the inside upper corner. If the metal of the head of the rail is of coarse texture and unsound, it crushes for one eighth to one fourth of an inch under the wheel treads, and rapidly wears. See Figs. 8, 9, and 10.

Beneath the rolling wheel contacts the pressures are distributed both to the rail as the bearing surface and girder, by an area of steel from one tenth to one half of a square inch, which resists flow by support of the contiguous metal around and under the point of contact. While there is a slight compression of the metal, owing to its elasticity, it does not take a decided permanent set if solid, except by slight flow upon the extreme contour of the contact, to conform by its malleability to the average rolling wheel tread.

Stremmatograph tests on different sections show that, as the stiffness increases, the unit fibre stresses decrease, though the bending moments carried to make a smooth running track are augmented. This amplifies the wheel contact pressure intensity per square inch, imposing more work upon the metal in the bearing surface from the mechanical relations it sustains as part of the rail section in the more efficient girder or engineering structure. The quantity of metal in the bearing surface is limited in width of head, and reliance for effective service must be upon sound metal of good physical properties.

The axle loads, speed, and expended tractive effort produce two, three, or more times the burden by the passing wheels on the bearing surface of the present stiff rails than was borne by the former limber sections.

The bending moments carried by the light rails were only from 150,000 to 200,000 inch-pounds under the heaviest driving-wheel loads of the locomotives. On the 5⅛-inch 80-pound rails, under the present wheel-loads, they are from 250,000 to 400,000 inch-pounds, while on the stiff 6-inch rails they may be from 400,000 to 500,000 inch-pounds. See Table No. 1.

The physical properties of the best early steel rails were usually adequate for their conditions of service.

The metal in the section was of fine texture, solid, homogeneous, and in the bearing surface had malleability when its limits of cubic elasticity were surpassed, and ductility as a girder when its limits of linear elasticity were exceeded.

It is understood that, with the increase of the stiffness and strength of the section, the unit fibre strains would be decreased in the heavy and stiff rails.

It is not known that, due to the looseness of the rails on the cross-ties, the latter in the ballast, and the depression of the roadbed to carry the wheel-loads, the bending moments augment with the stiffness of the rails. This reduces slightly the area of contact between the rail-head and the wheel-tread, and increases the intensity of the pressure per square inch, which has, and can be sustained by metal of sufficient physical properties.

The Guide. The Side of the Head for the Passing Wheel Flanges.—A track of which the alignment is nearly all tangent, the functions of the metal exercised principally will be in the bearing surface, and for the entire section as a girder to sustain, guide, and distribute the wheel-loads.

The fillet, in the throat of the flange of the wheels, by practically a rolling contact with the upper corner of the head, becomes sufficient to guide the passing trains without undue abrasion.

The three functions of the metal are required on curves, especially with combined gradients, to guide and change the direction of the trains, by the passing wheel flanges, which, by the pressure required, produces severe cutting abrasion on the inside rail-head, and on the opposite rail wear and flow of metal in the bearing surface by the wheel treads.

The loss of metal on the side of the head of the rail, as the "guide," by abrasion from the wheel flanges, is 3 to 10 times more rapid than from the same wheel treads in the bearing surface.

Rails of a quality of metal which on tangents will wear 6 to 10 years, on curves combined with heavy gradients may become flange-worn in 12 to 18 months.

Rails require width of head, tough, tenacious metal of fine texture, and hard as permissible, for the girder, to withstand long the abrasion of the wheel flanges.

The Entire Section as a Girder and Engineering Structure.—Provision for the mechanical properties of the section is made in the design, while as a metallurgical product the requisite physical qualities must be secured by the chemical composition, heat treatment, and method of manufacture, a series of difficult problems.

Safety is the first consideration, and the physical qualities must be confined to those for the bearing surface, guide, and girder, which will withstand the service of the rail in the track without fragility in the cold weather, which would render them unsafe.

The rail section as the girder, distributing its wheel-loads by longitudinal components of stress, must be made of a metal which permits, by its elasticity, the necessary flexures of the rails to carry the moving trains. The unit fibre strains in the limber steel rails were high, for those with elastic limits of only 30,000 to 35,000 pounds were limited to .001 of an inch extension per inch, before acquiring sets in service. Those in which the elastic limits were from 45,000 to 56,000 pounds only were capable of sustaining the unit fibre strains of the bending moments due to the wheel effects, without taking sets in the track.

Unit fibre stresses of 25,000 to 35,000 pounds under high-speed trains are to be expected in the rails, for they must sustain the wheel-loads of the locomotives, the dynamic effects due to speed, and those due to the expended tractive effort.

The maximum unit fibre stresses in rails under daily trains are often two and three times higher than is considered permissible for bridge members. In rails, a stress under the wheels of either compression or tension lasts but a fraction of a second before reversal, while in bridge members a stress may continue for several seconds.

The sound metal in the heavy and stiff sections which is enduring the service, has elastic limits of 55,000 to 60,000 pounds — nearly equal to the ultimate strength of the steel used for bridge members — and in addition has an elongation of 15 to 20 per cent in two-inch specimens.

The Barrow or other brands of early limber steel rails, in which the elastic limits ranged from 53,000 to 56,000 pounds per square inch, proved sufficient for the bearing surface, the guide, and the girder, for their limited mechanical properties and wheel-loads. The actions of the limber sections as engineering structures in the track are illustrated in Figs. Nos. 3 and 4, by a reproduction of a portion of one of the original diagrams by the Track Indicator, of the surface undulations of 10 rails. In Fig. 3 the joints are worn and low, and gave shocks to each passing wheel. The rails did not form a continuous girder for the strains in the general depression. The undulations as measured were 12 feet per mile.

Fig. 4 is from 10 new rails, poorly finished at the mills, and the cross-ties cut in the rail seats. Undulations, 8 feet per mile.

Fig. 5 is from 10 stiff 6-inch 100-pound rails upon the same roadbed as No. 4, the joints not being indicated; the undulations, 1 foot 9 inches to 2 feet per mile.

The stiff 5⅛-inch 80-pound rails do not show the joints until after years of service. Undulations, 2 feet and 9 inches per mile.

Figs. 6 to 11, inclusive, are photomicrographs of the structure of steel rails, each magnified 50 diameters.

Fig. 6 is from a Barrow rail 1868, and nearly all of the early steel rails had a similar structure. It is of fine texture, and has high limits of cubic elasticity. The steel was 0.40 in carbon and rolled from hammered ingots and blooms at a low temperature. The output was less than 200 tons per day and sold for $120 in gold per ton.

The steel for the heavy sections should be of fine texture, sound, homogeneous, and tough, though more difficult to secure than in light sections.

The chemical composition, according to the weight of the section, ranges as follows: Carbon 0.50 to 0.65, manganese 0.90 to 1.20, silicon 0.10 to 0.20, phosphorus and sulphur, each not to exceed 0.07. In ores containing 0.10 in phosphorus, the carbon is reduced 10 to 15 points.

The ingots are bloomed in trains and rolled direct into rails at some mills, and in others the blooms are reheated for final rolling.

The structure for the finished rails is granular and often too coarse for durable service in the bearing surface and guide, and fragile as the girder.

Attention is given to the rolling and finishing temperatures, to improve the structure.

Fig. 7 shows the structure of the first 6-inch 100-pound rails rolled 0.60 in carbon, and has rendered excellent service under the heavy wheel-loads.

Fig. 8 is from an 80-pound rail, 0.45 carbon and 0.10 in phosphorus — coarse, granular, and contains occluded gases.

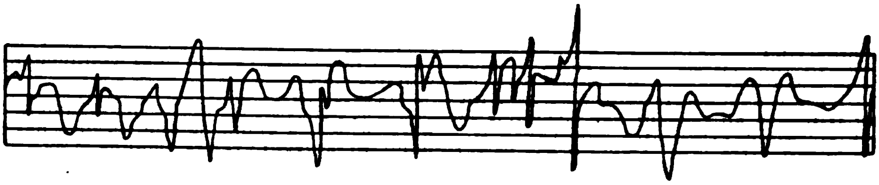

FIG. 3.— Surface undulations 4½ inch 65 lb. rails 1881. Joints low and worn.

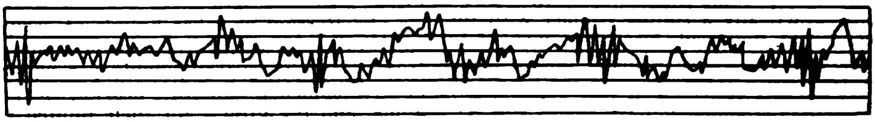

FIG. 4.— Surface undulations, 4½ inch 65 lb. new rails 1888. Wavy finish and cross-ties cut in rail seats.

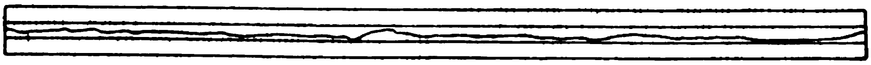

FIG. 5.— Surface undulations 6 inch 100 lb. rails 1892. Joints do not show their location.

Fig. 9, from the same rail, shows the structure as crushed for one fourth of an inch in depth in the bearing surface.

Fig. 10 is from a 100-pound rail of about the same chemical composition as No. 8, and crushed as a frog point after three months' service. The coarse structure has low limits of cubic elasticity and is fragile.

Fig. 11 is from an 80-pound rail which is rendering good service. The coarse structure of Figs. 8 to 10, inclusive, was due to the excessive heating and high phosphorus.

Rails in large sections have and can be made, by proper care in manufacture, which will be durable.

The 6-inch 100-pound rails of elastic limits of 60,000 pounds per square inch, laid on the "In-bound Main" at Grand Central Station, New York, in 1895, have carried over 300,000,000 tons, with only a loss in height of 3/32 of an inch in the bearing surface, exceeding the service of any light sections.

Rails at the mills are manufactured in two standards of length, 30 and 33 feet, with 10 per cent of shorts. They are laid in the track with either alternate or opposite joints, the former being general in America and the latter on the Continent. The joints may be suspended or supported, the former being common, though the latter prove to be the more efficient for long service, in making the rails a uniform, continuous girder under the passing trains. The types of joints as commercial products are numerous. The plain angle bar, with a thin web which can be punched out of steel of 55,000 to 60,000 pounds elastic limits, when in 36- or 40-inch lengths with 6 bolts, forming three-tie supported joints, has not been excelled for long, efficient service.

The number of cross-ties, 7 x 9 inches, 8 feet or 8 feet 6 inches long, range from 16, 18, to 20 per 33-foot rail. The ballast is of gravel or broken stone, 8 to 12 inches in depth, under the cross-ties in the main line tracks.

The periods of time which indicate the correlations between the sections as engineering structures and the driving-wheel loads, show that they have doubled practically on the stiff steel sections in the last 15 years.

The railroad companies have been quick to take advantage of such realities, by replacing their limber by 80-, 90-, and 100-pound stiff rails as the only and most economic method by which earnings could be saved, from an average freight rate of less than 1 cent per mile.

TABLE NO. 2. DRIVING-WHEEL LOADS IN RELATION TO SECTIONS OF RAILS.

Section	*Date*	*Pounds per wheel*
Strap iron	1826 to 1833	1,700 to 4,000
Iron tee	1833 to 1863	7,000 to 10,000
Light steel	1863 to 1890	10,000 to 13,000
Heavy and stiff steel	1890 to 1905	20,000 to 25,000

I was able to estimate and state the reduced undulations the stiff rails would record under my Track Indicator before they were rolled in 1883. They denoted higher standards than had been previously attained, and seemed improbable to officials.

The computed results for the Boston & Albany Railroad, with its curvature and heavy gradients, were, that the condition of track would be indicated between the 15th and 16th lines on the condensed diagrams.

The company commenced to lay their 95-pound rail in 1891, completed the line in 1897, and the average sum of the undulations per rail per mile, for the track inspection, was 15.42 lines on the condensed diagrams. I made the rails of 0.60 to 0.65 in carbon, the phosphorus not exceeding 0.06, and they were smoothly finished at the mills, to achieve definite effects.

The practical results since the transition from the limber to the stiff sections show that it has been imperative to introduce them, to carry the greater wheel-loads and check the rapid destruction of the cross-ties, which cost twice as much as the rails. The railroads have been enabled, without any other attention to the roadbed, to double practically the capacity of their tracks, by the increase of 60 to 100 per cent in the stiffness of their rails.

The important purpose in the construction of the superstructure of the track is to reduce and distribute the wheel-loads to such pressures, as the cross-ties and roadbed can sustain several thousand repetitions without decided permanent change, and the transition from the limber to the stiff rails has shown that this is the quickest engineering construction to load the foundation, for increased capacity.

Another method of distributing the loads and reducing their intensities to the ballast is by close wheel-spacing of the locomotives and cars — a feature of American practice.

The cross-ties under the limber sections were cut out in the rail seats by the intense pressures, while the ballast was overloaded to sustain 3,000 to 4,000 pounds per square foot. The stiff rails check the mechanical abrasion of the cross-ties, which can now be treated, and by that process add many years to their service.

The stiff and strong sections have enforced replacing the iron and steel bridges with those capable of carrying as heavy equipment as the rails.

The enlargement of the passenger locomotives — which had not been possible on the limber steel sections, owing to their weakness as girders — made rapid progress on the stiff rails, and in the Atlantic types now (1905) weigh 145 tons, while in the Pacific types 161 tons.

Equally useful to the railroads and community, beside the fast trains, has been the possibility of increasing the weight of the passenger, express, and mail trains to 500 or 600 tons, and run them upon schedules but little slower than those at high speeds and limited weight, the resistance being, on stiff rails at 55 miles, per hour about 11 and 10 pounds, respectively.

Freight locomotives of four, five, and in one type six, pairs of driving wheels, weight from 150 to 175 tons, are not severe on the tracks of stiff rails, when distributing their load and expended tractive effort under so many drivers. Freight trains of 2,000, 3,000, and 4,000 tons are in daily operation, compared to those of 500 or 600 tons on the limber rails.

The resistance of heavy trains is less per ton than those of smaller units. Freight cars of 60,000, 80,000, or 100,000 pounds capacity, with a spacing not exceeding 18 or 20 feet between the inside wheels of the trucks, make the general depression of the track continuous from the front pilot wheel to the rear wheel of the train. The foundation is loaded more favorably, and the train resistance decreased.

The greater capacity of freight cars has reduced the freight-train mileage, effecting an economy. In 1893 the freight-ton miles in the United States were 93,588,111,833, and the freight-train miles 508,719,506. In 1903 it was 173,221,278,993 ton-miles, and the freight-train miles only 526,312,433, an increase of 79,633,167,160 ton-miles, for less than 4 per cent more mileage.

This teaches the correlations between the enlarged equipment on the stiff and strong rails.

The smoother track on the stiff rails reduces the train resistance by causing the centres of gravity of the wheels to roll forward with limited undulations, and this in turn the centres of gravity of the bodies of the locomotives and cars, one of the important factors in the recent progress of transportation. This fact of track construction and maintenance has not attracted academic discussion, but it does receive consideration and work as the railroad companies look to the physical condition of their tracks and the high standards of maintenance for economy and safety of operations. The expenditure for labor by the railroad companies of the United States in 1903 was $139,000,000 to maintain the surface of the tracks. This sum represents annually nearly 1 per cent of the total cost of the investment and construction of the railroads.

The permanent way, composed of so many members safely but not rigidly connected, does not become a conservative system in which the strains incident to the passing locomotives and cars may be mathematically traced in their distribution in the rails, cross-ties, ballast, and subgrade, as in bridge members with rigid connections.

The International Railway Congress, at its second, third, fourth, and fifth sessions, had elaborate mathematical papers and discussions upon the subject based upon the consideration of static wheel-loads, then assuming what would take place under rolling loads.

The conclusions were not accepted in this country, in some respects, for they were not in accordance with the results of experience of distributed wheel-loads of American practice.

Prof. A. Flamache, chief engineer of the Belgian railways, considered all of the previous papers, and in the January Bulletin, 1904, of the International Railway Congress, Brussels, presented 30 pages of mathematical investigations, and concludes that the problem of what occurs in the rail under the rolling loads cannot be stated without more instrumental investigations for analysis.

Measurements of the unit fibre strains in the rails under moving trains have not been made abroad.

I ascertain the unit fibre strains in the rails under the moving locomotives and cars by means of my Stremmatograph, an instrument of precision, which segregates five inches in length of the base and records on a phosphor bronze slide the elongation and compression of the metal due to the passing wheel-loads.

The strains are measured under a special microscope, and from the modulus of elasticity of the steel the unit fibre stresses in pounds are ascertained. Then from the factors expressing the mechanical properties of the section the bending moments of the wheel effects are determined, as exhibited in Test No. 257, one of a series of precision, on stiff rails, to trace the distribution of the stresses under the moving locomotives. This seems to be for all the wheel contacts, as though distributed from the centre of gravity of the locomotive, in accordance with mechanics.

The test was repeated for the same train 30 December, and the total stresses compared within less than ½ per cent. The average sum of the positive bending moments for both was 11.48 inch-pounds per pound of static load on 5⅝-inch 80-pound rail. Similar tests upon 6-inch 100-pound rails, at slower speeds, have been secured, of equal precision. The wheels must be perfect, and the engines performing the same work, for tests of precision. Engines with swing trucks do not give high degrees of exactness.

The tests also enable comparisons to be made between the types of locomotives in distributing their loads upon the rails.

At the same place, date, and speed as Test No. 257, a 10-wheel locomotive, weight 282,900 pounds, drawing the "Southwestern Limited," weight 910,000 pounds, the positive bending moment was 9.82 inch-pounds per pound of static load, for one rail. The closer wheel-spacing of the heavier, larger, and stronger locomotive, distributing its expended tractive effort under six instead of four drivers, was easier on the foundation or sub-grade than the eight-wheel type. This had been inferred from practice, and now confirmed by measurements.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

P. H. Dudley's Stremmatograph Tests, 23 Dec. 1899.

No. 257. Track, No 1. Location, 6° curve 600 feet west of mile post No. 10. Rail 5⅝ inch, 80-pound. Moment of inertia, 28.5 4th-power inches. Cross ties. Length, 8 feet. Width, 9 inches. Thickness, 6 inches. Wood, Y. P. Weight, 155 pounds. No. 18 per 30 feet rail. Average weight of superstructure per yard, 449 pounds. Three-tie supported joints, 36-inch splice bars, stone ballast. Train No. 51, Empire State Express. Number of cars, 4. Weight, 430,000 pounds. Locomotive No. 870. Weight: trucks, 44,500 pounds; drivers, 86,500 pounds; tender, 89,000 pounds; total, 220,000 pounds. Speed, 42 miles per hour. Temperature, 40° F. The apparent mean unit fibre-stresses in the base of one rail were as follows in pounds:

			Per wheel.	Per wheel base of			Per lb. of wheel base of	Wheel effects	
				Drivers and trucks of engine, tender and cars.	Engine and tender.	Locomotive and cars.	Drivers and trucks of engine, tender and cars.	Positive bending moments under wheels. Inch-lb.	Negative bending moments in wheel spacing. Inch-lb.
LOCOMOTIVE		Extra wave preceding truck wheel							
ENGINE, Truck		Compression in front of truck wheel........	709	....	....	....	......	....	8,083
	—O	Tension under front truck wheel...........	13,463	....	....	....	......	153,478	....
		Compression between front and rear truck wheel	709	23,857	....	....	1.072	....	8,083
	—O	Tension under rear truck wheel	7,086	....	....	....	......	80,780	....
Drivers		Compression between truck wheel and front driver	3,779	....	83,024	....	1.369	....	43,081
	—Θ	Tension under front driver..............	26,926	....	....	....	......	306,957	....
		Compression between drivers..............	4,252	59,167	....	....	......	....	48,473
	—Θ	Tension under rear driver...............	24,564	....	....	....	......	280,030	....
		Compression between rear driver and front tender wheel..........	3,071	....	....	127,075	......	....	35,017
TENDER, F. T.	—O	Tension under front tender wheels.........	10,157	....	....	....	......	115,790	....
		Compression between tender wheels, front truck	0	20,904	....	....	0.931	....	0
	—O	Tension under rear tender wheel, front truck	8,031	....	....	....	......	91,553	....
		Compression between front and rear tender trucks	2,362	....	44,051	....	......	....	26,926
R. T.	—O	Tension under front tender wheel, rear truck.	8,976	....	....	....	......	102,326	....
		Compression between wheels of rear tender truck	472	23,147	....	....	1.031	....	5,381
	—O	Tension under rear tender wheel...........	11,337	....	....	....	......	129,242	....
		Compression between tender wheel and first car wheel..........	2,362	....	....	....	......	....	26,926
FIRST CAR, Front Truck	—O	Tension under front wheel of first car......	9,684	....	....	....	......	110,397	....
		Compression between first and middle wheel.	272	....	....	....	......	....	3,101
	—O	Tension under middle wheel..............	12,764	34,756	....	....	1.310	145,310	....
		Compression between middle and rear wheel.	1,417	....	....	....	......	....	16,154
	—O	Tension under rear wheel...............	8,503	....	....	....	......	96,934	....
		Compression back of wheel...............	945	....	....	....	......	....	10,773
		Compression in centre of wheel space.......	0	....	....	....	......	....	....
		Compression in front of wheel of rear truck.	2,362	....	....	....	......	....	26,926
Rear Truck	—O	Tension under front wheel of rear truck....	9,920	....	....	....	......	113,088	....
		Compression between front and middle wheels	1,181	....	....	....	......	....	13,495
	—O	Tension under middle wheel..............	8,379	33,895	....	....	1.280	95,521	....
		Compression between middle and rear wheel.	2,362	....	....	....	......	....	26,926
	—O	Tension under rear wheel................	8,976	....	....	....	......	102,326	....
		Compression between trucks of first and second cars..........	709	....	....	....	......	....	8,083

Test No. 257.—Reduction of sum of positive and negative bending moments to one pound of static load for one rail:

	Inch-pounds
Engine, sum of positive bending moments..	821,245.00
Engine, sum of P. B. M. per pound of static load	12.65
Engine, sum of negative bending moments.	125,234.00
Engine, sum of N. B. M. per pound of static load	1.92
Tender, sum of positive bending moments..	438,911.00
Tender, sum of P. B. M. per pound of static load	9.75
Tender, sum of negative bending moments..	63,279.00
Tender, sum of N. B. M. per pound of static load	1.40
Locomotive, sum of positive bending moments	1,260,156.00
Locomotive, sum of P. B. M. per pound of static load	11.46
Locomotive, sum of negative bending moments	188,513.00
Locomotive, sum of wheel effects	1,448,669.00
Locomotive, sum of N. B. M. per pound of static load	1.71
First car, sum of positive bending moments.	663,576.00
First car, sum of P. B. M. per pound of static load	12.52
First car, sum of negative bending moments	141,187.00
First car, sum of N. B. M. per pound of static load	2.66
First car, sum of wheel effects	804,763.00

Weight of one-half of car, 53,000 pounds.

The Stremmatograph tests confirm that it is the combined wheel-loads and spacing which produce the specific deflections in the rails, and limit and control them, more than the flexible supports of the cross-ties. This fact is the fundamental principle of the American theory and practice of loading favorably the sub-grade through the distribution by their wheels of the total loads of the locomotives and cars. The stiff rails increased this efficiency to such an extent as to empower doubling the axle and total loads of the locomotives and cars, in the past 15 years, and at the same time secure and maintain smoother and better tracks than was possible on the lighter and limber rails.

The correlations of the stiff rail sections and the equipment are demonstrated and established by practice and analysis of tests, for under the wheel contacts in the general depression the positive bending moments are constrained by the negative bending moments, which check the deflections under the wheels, similar to the restrained beam of mechanics. To differentiate between the functions of the rail section and the "restrained beam" of mechanics, I designate the rail section on flexible supports under the rolling loads of the locomotive a constrained beam.

It is unique in the use of material or beams, that by a subdivision of the total load of the locomotives through the progressive wheel contacts, such favorable loading and distribution are made on the rail, and foundation; that the section by the function of its mechanical properties, in combination with its flexible supports and the sub-grade, is stiffened and strengthened — a reciprocal benefit.

This has been so advantageous with the American type of equipment that with all of the increase of axle and total loads, upon the stiff rails, reconstruction of the roadbeds has not been required. The wheel-loads carried are heavier than those abroad, and with the higher speed demonstrate that the essential running stability is secured between the equipment and permanent way, as well as upon roadbeds which are considered more rigid. Baron Von Weber, director of the state railways of Saxony, in 1869, published a work on the stability of the permanent way, from his tests with engines of three pairs of drivers without trucks. His wheel-loads did not exceed 13,000 pounds, and he concludes, erroneously, that engines with two pairs of drivers would be preferable, and that the cross-tie supports should be replaced by a longitudinal system for heavier wheel-loads. His tests were valuable in many respects, though they did not lead to the consideration of all the elements of the running stability between the equipment and the permanent way, for we are now carrying driving-wheel loads twice as heavy as those in his investigations.

The running stability of the American railroads can be augmented by 9-foot treated cross-ties, screw spikes, and attention to the wheel-base of the engines.

The iron rail sections empowered the establishment of the railroads. The present development, efficiency, capacity, and prosperity has been in the period of the stiff steel rail sections, as engineering structures, and their correlations to equipment and operations of railroads.

P. H. Dudley, C. E., Ph.D.,
New York Central & Hudson River Railroad.

Rails and Rail Shooting. Any birds belonging to the typical genera of the family *Rallidæ* are popularly called rails, probably in reference to their harsh rattling cries, but the name is more particularly applied to certain species, others being known as marsh hens, crakes, etc. The family is included in the order *Grallæ* or *Gruiformes*. The family is a large one composed of numerous species of moderately sized birds of generalized structure, found in most parts of the world. The body is compressed, the legs strong, the feet very large with long toes, which are lobately webbed in the coots, the wings and tail very short, the bill strong and variously shaped, but never greatly elongated nor provided with a sensitive tip; and the colors are usually obscure and sober. About 35 genera and 180 species of *Rallidæ* have been recognized, but authorities differ concerning the retention of some of the more aberrant forms within the family. Three subfamilies are represented in the North American fauna: the *Fulicinæ*, or coots, with lobate marginal webs on the toes and a horny frontal shield; the *Gallinulinæ*, or gallinules, with a frontal shield, simple toes, and usually richly colored plumage; and the *Rallinæ*, or typical rails, in which the family characteristics are best displayed, and there is no frontal shield nor any webbing on the toes.

Most of the rails are marsh-loving birds, their long toes admirably serving to support them on the soft mud, and their narrow compressed bodies facilitating movement among the stems of grasses and reeds. Owing to their skulking and largely nocturnal habits they are difficult to observe, and, except by gunners, their abundance is not generally known. They run well and to escape danger trust to their ability to slip quietly into a place of concealment. They seldom fly, and, owing to the shortness of the wings, only in a weak, uncertain manner, but nevertheless some of the species perform extensive migrations. In feeding they are chiefly carnivorous but never probe the mud for worms.

etc., in the fashion of snipes, nor strain it as do the ducks. The nest is usually a rude bulky platform of dried rushes, etc., slightly elevated above the wet ground and the numerous eggs are thickly spotted. The young are fully downy and are said not only to run but to swim well as soon as hatched.

Besides the corncrake (*Crex crex*), which occasionally wanders from Europe to our shores, 12 species of true rails occur within the boundaries of North America. They belong to two genera. The king rail (*Rallus elegans*) or fresh-water marsh-hen is our largest species, reaching a length of 18 inches and a wing expanse of two feet. It is known by the rich cinnamon and chestnut hues of the under parts and the strong streaking of the plumage above. This species is abundant in the fresh-water marshes of the eastern United States but, although occasionally seen in New England, is rather southerly. Except for its habitat and the character of its food, which consists largely of aquatic insects, leeches, and wild rice in season, the habits of the king rail closely resemble those of the next species. In the salt-water marshes from Connecticut southward along the Atlantic and Gulf coasts the king rail is replaced by the well known clapper rail or salt-water marsh-hen (*Rallus crepitans*), which is extremely abundant from New Jersey southward and is resident in the southern half of its range, but migratory northward. It inhabits the reed-covered marshes intersected by ditches and creeks which border so much of our coast within the beach line, and its presence is especially evident during the breeding season when the loud clattering cry is heard incessantly both by day and night. All kinds of snails, crustaceans, and worms inhabiting such regions constitute its food. The nest is a heap of dried reeds and grasses elevated just above the water by the side of a ditch, and usually concealed by an artful overarching of reeds. As many as a dozen, but more frequently about eight eggs, are laid; they are oval, of a cream or buff color and thickly blotched with brown and lavender tints. The clapper rail is slightly inferior to the king rail in size and is of a blended grayish color tone, rather than a streaked red. Closely related species are the *R. obsoletus* of California and *R. scottii* of Florida. The Virginia rail (*R. virginianus*) is about 9 or 10 inches long and in color a perfect miniature of the king rail. Unlike the latter it inhabits salt and tide-water as well as inland marshes, and is very widely distributed throughout temperate North America and southward. It is a regular migrant, in most of the Northern States and Canada, remaining from April to September to breed. Although generally common, they are best known by their nocturnal and diurnal cries. In nesting and other habits they resemble the clapper rails, but the eggs are of course much smaller. The Carolina or sora rail or crake and the yellow rail belong to the genus *Porzana*, which differs from *Rallus* in having the bill short and stout instead of long and slender. The former (*P. carolina*) is eight or nine inches long, brownish above and unspotted below, the latter (*P. noveboracensis*) is only about six inches long, with much yellow above and the breast spotted. Both appear to range widely in North America, but the former is everywhere a far more abundant bird. The sora, also erroneously called ortolan, is the best known and during the migrations the most plentiful of the rails in all suitable reedy marshes along the shores of lakes and rivers, and it breeds in similar localities in the Middle States and northward. A third related species, the black rail (*P. jamaicensis*), is rarely taken. The North American rails are all marsh birds, but the European corn crake prefer the cultivated fields, and in New Zealand and other Southern islands many remarkable forms of field rails and some curious flightless and burrowing species are found.

Rail-shooting in the autumn, when they, and particularly the Carolina rail, congregate in immense numbers in the river swamps, has many followers; but it can hardly be called a sport, being nearly on a par with the annual slaughter of reed birds which occurs at the same time and places. The method is very simple: Each gunner has an assistant who poles him about in a flat-bottomed boat or skiff through the creeks and passages which everywhere intersect the swamps. Usually this is done at high tide, owing to the shallowness of the creeks at other times and because the rising water restricts the area on which the birds can run. Sometimes spaniels or other dogs are employed to drive the birds, but this is unnecessary, as they are easily seen as they run along the banks of the creeks or rise in short labored flight. Enormous numbers, often running into the hundreds, may be secured by a skilful shot who has mastered the problem of shooting from an unsteady boat. During the gunning season the sora feeds largely on the seeds of reeds and wild grains, becomes very fat, and is a truly delicate morsel. The other species are also sought but to a less extent. At times of unusually high tides great numbers of clapper rails are killed along the New Jersey coast as they huddle bewildered on little islands and masses of reeds in the flooded salt meadows. Immense numbers of the eggs of the same species are also gathered for food. Consult: Baird, Brewer, and Ridgway, 'North American Water Birds' (Boston, 1884), and Roosevelt, 'Game Water Birds' (New York, 1884).

Rails and Structural Shapes, Manufacture of. One of the most important branches of the iron and steel industry is the manufacture of rails. Up to about 1855, all rails were made of wrought iron. In England beginning about 1767, various forms of cast-iron and wrought-iron rails were employed, the first being a grooved rail for tramway purposes, which was subsequently developed into the regular railway by the use of cast-iron flanged rails. The first wrought-iron rail was patented in England by Birkenshaw, in 1820, and on account of its peculiar form was known as the "fish-belly" rail. It was the first to be rolled in continuous lengths embracing several spans, and was laid in cast-iron chairs spiked to stone blocks set at intervals of 3 feet. It weighed about 33 pounds per linear yard. Its manufacture by the rolling process, however, was quite difficult, and it was superseded by the "flat-foot" rail which combined a solid head with a flanged base and was laid by being fastened to timber sleepers or ties by spikes driven through the holes in the flange.

The flat-foot rail was followed by the bridge-rail, the double-headed rail, and the bull-headed rail. The last named, although involving a great waste of metal, owing to the excessive thickness of the web, is used exclusively in England, while in the United States and almost all foreign countries, the rail of the flanged T-section is universally employed. It was invented by Col. R. L. Stevens, in 1830, but the form in use in America is a modification suggested by the special committee appointed by the American Society of Civil Engineers, in 1893; while the form used in Europe is that invented by Sandberg. It is usually made in lengths of 30 feet, but rails as long as 60 feet are used to some extent. In weight, it varies from 25 to 100 pounds per linear yard, according to the amount of traffic, the speed of transportation, and the gradients and curves of the roads upon which it is used. About 1865, a few years following the discovery of the method of manufacturing Bessemer (q.v.) steel, rails of that material were experimentally rolled in the United States and soon began to supplant those of wrought iron. At the present time all rails are made of steel, and they have, probably, contributed more towards the rapid development of this country than any other single product of the steel industry. The raw materials consist of iron-ore, coke, and limestone, mixed in proportions as follows — ore 2 pounds, coke 1 pound, and limestone 1⅓ pound. Two fundamental processes of manufacture are employed — the reduction of the ore in the blast furnaces and the conversion of the molten metal into steel in the converters, followed by the operations of the rolling mill. (See IRON AND STEEL.) The Bessemer process of conversion is generally employed on account of its rapidity as compared with the open-hearth process, taken in connection with its capability to produce a grade of metal of a quality sufficiently high to satisfy the general specifications for rails. In the manufacture of steel rails, the work of smelting the iron in the blast furnaces is continued day and night, year in and year out, without intermission, but the converters and the rolling mills are generally shut down from 1.30 P.M., Saturdays, to 5 P.M., Sundays. During the intervening times, the product of the blast furnaces instead of being poured into the mixers (by which the casts obtained from the different blast furnaces at varying temperatures and qualities, are reduced to a common temperature and quality), are run into the pig casting machine which consists of a series of parallel endless chains of molds arranged to pass in front of the pouring mouth of the ladle. The molds receive the metal at the lower end of the chain, and deliver the casts at the upper end of the chain, where they are loaded upon railway cars for shipment.

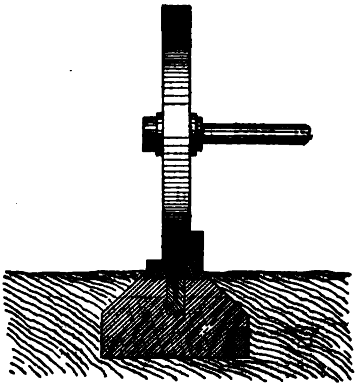

FIG. 1.—Tramway rail.

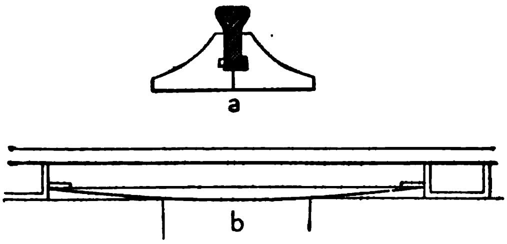

FIG. 2.—Fish-belly rail. (a) Section. (b) Side view.

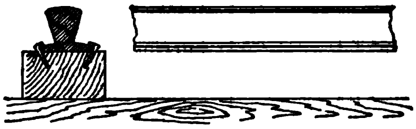

FIG. 3.—Flat-foot rail.

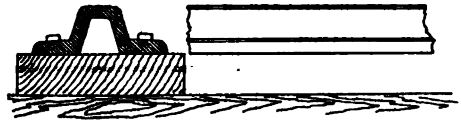

FIG. 4.— Bridge rail.

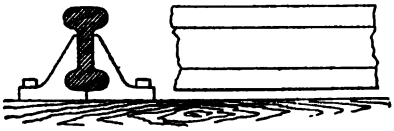

FIG. 5.—Double-headed rail.

In the regular work, as soon as the ingot cast from the metal purified in the converters, is set, the mold is drawn from it by a hydraulic stripper, and it is raised by an overhead electric crane and then lowered into the soaking pit, where it is brought to the proper temperature (white heat) for rolling. It is then taken to the blooming mill and passed through the blooms (rollers) seven times and reduced to a section varying in size according to the size of the desired rail. The section of the ordinary rail used on the railroads is 9¼ inches square, and

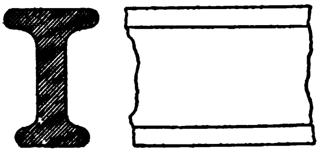

FIG. 6.—Bull-headed rail.

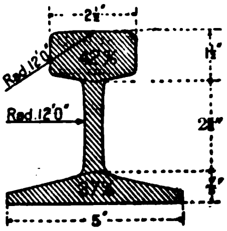

FIG. 7.— Flanged T section rail — 80 lbs. per linear yard. Standard Am. Soc. Civil Engineers.

the ingot when rolled to that section attains a length of about 15 feet. It is then sheared into two or three lengths, as the case may be. These pieces called blooms after being heated in the bloom furnaces are carried to the rail mill, which consists of three sets of rollers — the roughing rolls, the intermediate rolls, and the finishing rolls, through which the bloom is passed successively. Through the first set it is passed five times and reduced approximately to the section of the desired rail. It is then, without being re-heated, passed five times through the intermediate rolls and reduced more closely to the desired shape. If the rail is of the lighter variety, weighing from 50 to 70 pounds per linear yard, it is then passed through the last set of rolls and finished on a single heat, with satisfactory results. But, if the rail is of the heavier class, ranging in weight from 80 to 100 pounds per linear yard, its tendency to retain heat longer, and therefore be passed through the finishing rolls at a temperature too high to give good results, is overcome by allowing it to remain upon a cooling table for an interval of time ranging from 45 to 90 seconds, and it is then passed through the finishing rolls at a lower temperature, thus giving a rail of a much better quality of metal, especially in the head of the rail. The rail is now sawed into the desired lengths, usually of 30 feet, and then passed through the cambering rolls, where it receives sufficient camber to prevent warping when it is being cooled. After being cooled off on the hot beds it is straightened, chipped, and filed, and is then ready for shipment as a finished product.

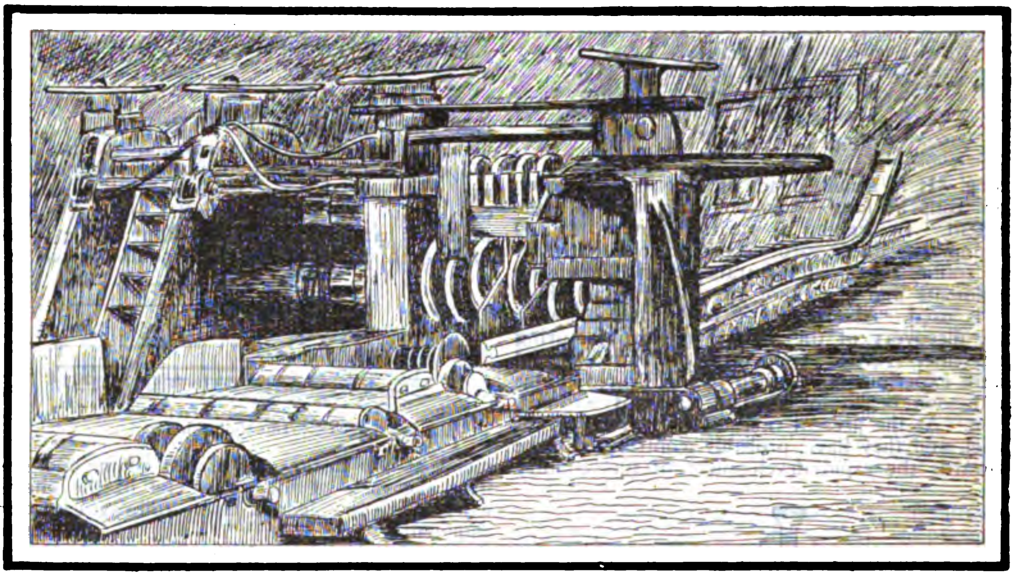

FIG. 8.—Rail passing through the intermediate rolls in the rail mill.

In the manufacture of "structural shapes" (a term which includes a great variety of angle-irons, T-irons, I-beams, Z-bars, eye-bars, channel-irons, and built-up posts, beams, and girders), used in the construction of modern buildings and bridges, the shapes are rolled from basic open-hearth steel of three grades — the rivet steel with an ultimate strength ranging from 48,000 to 58,000 pounds; the soft steel from 52,000 to 62,000 pounds; and the medium steel from 60,000 to 70,000 pounds. The elastic limit generally required is not less than one half of the ultimate strength, and the test pieces are required to be capable of being bent over through an angle of 180 degrees, without fracture. The raw materials consisting of ore and pig-iron, are melted down in the cupolas and are then run into the open-hearth tilting furnace, where an equal amount of cold scrap, in the form of steel junk, crop-ends, punchings, etc., from the construction shops, is added. The contents of this furnace, sometimes amounting to 75 tons, are poured into a hydraulic ladle crane, which is then swung over the casting pit, and the molten metal poured into the ingot molds in the usual way through the bottom of the ladle. The ingots when set, are re-heated in the soaking pit, and then passed through the blooming mill and reduced to blooms and billets of any required size. They are then rolled to the desired shapes, sawed into the required lengths, and then cooled on the hot beds. From the hot beds they are passed through the straightening rolls, and after being cut into exact lengths, as required, they are ready for the construction shop.

In the production of finished bridge members, the shapes are carefully laid out by wooden templates, in which the precise positions of rivets, angles, gussets, etc., are marked. The operation of building up requires great care and accuracy. The shapes are sawed or sheared to exact length, and the sides and ends faced and planed down as required by the drawings.

The small holes for bolts and rivets are punched by lighter forms of machinery driven by electric power; on the other hand, all pin-holes are first punched and then bored to exact diameter. In assembling, the rivet holes are properly registered, being reamed if necessary, and the separate parts bolted together, and finally riveted up by hydraulic, or pneumatic riveters. (See METAL-WORKING MACHINERY.)

In the manufacture of eye-bars, used in bridge construction, the tensile strength is limited to not more than 10,000 pounds below the test specimen of the grade of steel from which they are rolled. The eye-bar heads are formed by upsetting machines operated by hydraulic power, in which the heated end of the eye-bar is pressed to the desired circular form by the three-fold die of a hydraulic press, in a single operation. The head is then forged and punched at one heat, and then finished bored. Eye-bars are tested in a hydraulic testing machine capable of exerting a maximum pull of 700 tons. When an order of eye-bars is completed, one of the bars is pulled asunder in the machine. In general, they are required to show not less than 10 per cent elongation in the body of the bar, and they must break in the body and not in the eye.

W. MOREY, JR.,
Consulting Engineer, New York.

Rail'ton, Herbert, English artist: b. Pleasington, Lancashire, 21 Nov. 1857. He was educated at Mechlin, Belgium, and Ampleforth College, Yorkshire, and is very popular as an illustrator, among works which he has illustrated being the 'Jubilee Edition of Pickwick' (1887); 'Westminster Abbey' (1889).

Railway Associations. In the early days of railways their operation was but little more difficult to regulate than the service of the ordinary highway. The trains, few in number, were formed of connected stage coaches, or wagons, and were drawn sometimes by horses, sometimes by light locomotives. As traffic increased, trains multiplied, vehicles were enlarged, and the powerful engine of the present date, capable of hauling a train of a hundred modern freight cars, was eventually evolved. This great physical change has required a coincident development in rules and regulations, in order that the immense traffic of modern times, with its complicated movements over an interlaced system of roads, may be operated safely and efficiently. In this development each railway company formerly moved independently. The knowledge acquired by the officials of one company as the result of experiment and experience was unknown to the others, rarely communicated and sometimes jealously guarded. The problems presented eventually became so many and so intricate as to render the exchange of ideas and experience advantageous, if not imperative. This exchange has been mainly accomplished by means of railway associations. In no other line of business and in no other country has this co-operative work been developed so completely and so scientifically as among the railways of North America. It has been of incalculable value to the railway companies and to the traveling public.

There are more than 20 railway associations, national in their character, in North America; most of them are devoted to subjects connected with operation and the others to questions concerning traffic. The term «operation» includes the supervision of the movement of trains, the maintenance of the superstructure, buildings and rolling stock and the exercise of discipline. The term «traffic» refers to business concerning rates and regulations affecting passengers, freight or other articles transported. Of the organizations devoted to «operation» the most important and influential is The American Railway Association, which had in 1903 as its members 218 railway companies, operating 212,849 miles of railway,— about 95 per cent of the entire railway mileage of the United States, Canada and Mexico. The history of The American Railway Association has been one of gradual development. Dating as far back at least as 1872, joint meetings of operating railway officials of superior grades were held semi-annually, with more or less regularity, having for their object the mutual arrangement of the schedules of through passenger trains between the east and the west and intermediate connections. Aside from such business, the first important co-operative work of this body, then called «The General Time Convention,» was the approval of a detailed system of Standard Time proposed in April 1883, and its practical adoption in the United States and Canada on 18 Nov. 1883. Previous to that date every railway ran its trains by the local time of the city in which its headquarters were located, or some other arbitrary standard. There were over 50 standards in use, differing from each other by odd numbers of minutes. On the date named these were resolved into four standards based upon Greenwich meridian time, with differences of an even hour between them. Cities and towns throughout the country generally conformed their time to the new standards. Prior to 1883, the hand, lamp, whistle, color and bell cord signals in use upon the railway trains varied greatly. In some instances a motion of the hand or flag or the sound of the whistle would convey exactly opposite meanings to employees of different roads which used the same terminal stations for their trains. Bell cord and other signals were similarly at variance. A code of uniform train signals was adopted by the convention, taking effect 16 Nov. 1884. A similar organization of the operating officials of the railways between New York city and points in the South, called the «Southern Railway Time Convention,» was formed on 24 Oct. 1877. This body accepted and approved the action of the General Time Convention with respect to standard time and uniform train signals, and co-operated in their adoption. On 14 April 1886, these two bodies were consolidated and a national organization formed, called «The General Time Convention.» The name was changed to «The American Railway Association» in April 1891.

The object of the American Railway Association is the discussion and recommendation of methods for the management and operation of American railways. Its action is recommendatory, and not binding upon any member. Any common carrier operating an American steam railway is eligible to membership, subject to the approval of the executive committee. While any official of a member may be admitted to its sessions or serve on committees, the ranking official, who may be the president, vice-president, general manager, etc., casts the vote of the company or designates who shall cast it. Meetings are held semi-annually, in April and October. The work of the association is mainly accomplished through committees, and it is one of their functions to decide questions which arise in practice under the code of rules and to propose new rules to meet the great advances that are being made year by year in the methods of operation. Its technical standing committees are those on the subjects of train rules, car service and safety appliances. They examine into and report upon questions affecting the Standard Code of Train Rules, the movement of, distribution and accounting for cars, and the essential requisites of devices for safety appliances. Formerly each road had its own code of train rules. An employee, expert in the service of one road, found his knowledge useless on entering the service of another because the practice under the rules of the two was diametrically opposite. From the badly constructed and often discordant rules that preceded it, a scientifically arranged Standard Code of Train Rules was formulated, which each road could adopt and which most have adopted. This code has a glossary of technical terms and is divided into single-track rules for the movement of trains with or without the use of the telegraph; for movements by telegraphic train orders, with forms of orders; double-track rules; block signals and interlocking rules; for movements with the current of traffic on double track by means of block signals; and for movements against the current of traffic. In carrying merchandise from one part of the country to another the interchange use of the 1,700,000 freight cars belonging to the railway companies reaches enormous proportions. For many years the owner of the car was paid by the company using it at a rate based upon the miles it moved. Of recent times this was six tenths of a cent a mile, the account of the movement being kept by the company which paid for it. Complaints were frequent of long detentions of cars without compensation to their owners, causing delays affecting the transport of merchandise. Many attempts were made to bring about a change, but nothing practical was accomplished until The American Railway Association adopted a Code of Per Diem Rules in April 1902, and obtained the assents of the majority of the railways to a «Per Diem Agreement,» taking effect on 1 July 1902. This provided for the payment of 20 cents a day for the interchange use of freight cars, with a penalty rate of an additional 80 cents per day for the detention of a car over 30 days upon one road. Provision was made for the arbitration of differences arising under the rules and for their interpretation. A code of car service rules governs ordinary practices connected with this interchange service, not related to the compensation paid as above referred to. The essential requisites for train heating, train lighting, automatic couplers, power brakes, for the installation of block and interlocking signal apparatus, etc., have been prescribed. The educational and physical qualifications for employees have been carefully considered. The Association prescribed the standard height of draw bars for freight cars, under the act of Congress approved 2 March 1902. The following subjects have been at various times considered by special committees: the 24 o'clock system; the transmission of accurate time; uniform car mileage reports; general regulations for employees; standard wheel and track gauges; the metric system; railway statistics; standard box cars, and uniform cipher code. Uniform rules for the government of local car service (demurrage) associations were approved April 1898, and various recommendations of the Master Car Builders' Association have been submitted to and approved by The American Railway Association. The association is a member of the International Railway Congress, and sent delegates to its sessions in London in 1895 and Paris in 1900. It appointed an «American Section» to take charge of the arrangement for the seventh session of the Congress, to be held at Washington, D. C., in May 1905.

The Master Car Builders' Association is one of the oldest of these railway organizations. It was organized in 1867, and had 533 members in 1903. Its objects are the advancement of knowledge concerning the construction, repair and service of railroad cars, to bring about uniformity and interchangeability in their parts, and to adjust the mutual interests growing out of their interchange and repair. Its action is recommendatory, and not binding upon any of its members. A superintendent of the car department, master car builder, mechanical engineer, foreman of railroad car shop, joint car inspector or a representative of a car manufacturing company or other company owning over 1,000 cars, may become active members. Persons accredited by a railway company, and who have a practical knowledge of car construction, may become representative members. Such members, in addition to the vote of an active member, have one additional vote for each 1,000 cars owned by the company represented, upon all questions pertaining to the adoption of standards, etc. The membership includes many persons who are also members of the Master Mechanics' Association, and it is customary to hold the annual meetings of the two associations at the same place, one following the other. In the interchange of cars between railroad companies, questions of responsibility for repairs caused by accidents or by ordinary wear and tear are continually arising. In order to facilitate the settlement of such questions the Master Car Builders' Association has provided a code of rules governing the condition of and repairs to freight cars. Each company is required to give the same care to the cars of other companies in its possession, technically called «foreign cars,» as to its own cars. Cars offered in exchange service must be accepted, unless found to be defective as specified in detail in the rules. The rules include instructions as to methods of making repairs and billing the expense to the owners, with schedules of charges for labor and materials. For the settlement of all disputes arising under the rules an arbitration committee is provided. This association brought about the selection of the type of automatic coupler, now in use upon the railway cars in North America. It has also adopted standards, both for the construction and use of cars, which have proved of great value. These standards, 23 in number, are fully illustrated and published with each volume of its proceedings, together with 12 additional charts containing diagrams of recommended practices.

The American Railway Master Mechanics' Association was founded in 1868, is incorporated, and had 755 members in 1903. Its objects are the advancement of knowledge concerning the principles of construction, repair and service of the rolling stock of the railways. It considers questions affecting such joint action as may be required to give the greatest efficiency to the equipment of railways. Those eligible to membership must have positions above the rank of general foreman, having charge of the design, construction or repair of railway rolling stock; general foremen, if their names are presented by their superior officers, and two representatives from each locomotive and car building works. Persons having knowledge of science or practical experience in matters pertaining to the construction of rolling stock, may become associate members. The subjects assigned to committees for 1903-4 were as follows: Ton mile statistics; coal consumption in locomotives; locomotive front ends; locomotive driving and truck axles and locomotive forgings; boiler designs; revision of standards, such as shrinkage allowances, specifications and tests for boiler tubes; air brakes and signal instruction; piston valves; electrical equipment of shops and power houses; automatic stokers; locomotive frames; cost of locomotive repair shop; and safety appliances for locomotive front ends. The proceedings of the association contain a technical illustrated history of the development of locomotives, shop engines and machinery, from the date of its organization. The association has established four scholarships at the Stevens Institute of Technology.

The International Association of Car Accountants and Car Service Officers was organized in 1876, has 180 members and meets annually. Its object is the improvement of and the establishment of uniform practice in methods of car accounting and car service. The compilation of the statistics of operation of each road requires that the movement of cars, both loaded and empty, shall be accurately recorded. The interchange use of the 1,700,000 freight cars in service between the railway companies involves an immense amount of detail work in keeping and settling the accounts. Since the value of a freight car as a vehicle of transportation based upon its average earnings is between $2 and $3 a day, the importance of the figures involved in this accounting is self-evident. This branch of the service is part of the operating and not of the general accounting department. An official publication called the 'Railway Equipment Register,' contains lists of the cars of the several companies, giving in detail their numbers, dimensions, capacity and kind, such as box, flat, coal, etc., and other information essential to operating officials in regulating car movements and in car accounting under the rules of the association.

The Railway Transportation Association has for its object the development and solution of problems affecting transportation in the mutual interest of railway companies. It was organized in 1899, meets semi-annually and has 58 members, representing the owners of over 1,000,000 freight cars. Aside from general transportation topics, it considers such subjects as the responsibility for the transfer of freight interchanged; the handling of high class freight trains; the limits of class and size of freight cars; the interchange and distribution of equipment; tonnage; the loading of freight cars to their full capacity, etc. As the object of this association and that of the Car Accountants' Association somewhat overlap, and many officials are members of both bodies, a consolidation into one of enlarged scope, to include the objects of both, is probable.

The Association of Railway Telegraph Superintendents was organized in 1882, has 112 members, and meets annually. Its object is the improvement of the telegraph service. Its membership consists of persons who are connected with the telegraph, telephone, electric light, electric power or electric signal department of any railroad company. It has committees on the following subjects: telegraph cipher code; typewriter in railway telegraph service; and on composite circuits. The duties of telegraph superintendents cover the maintenance of the telegraph lines, as well as the supervision of the operators in the service.

The Train Dispatchers' Association of America has for its object the consideration of the best method of moving trains by telegraph, the establishment of a bureau of information, and the advancement of train dispatchers in efficiency in the performance of their duties. It was organized in 1888, is incorporated, has 868 members, and meets annually. The movement of trains by telegraphic orders, as commonly practised in North America, is unknown in Europe. The details of such movements are directed by designated telegraph operators, called train dispatchers, under the direction of a chief train dispatcher, attached to the staff of the superintendent, by whose authority the orders are given.

Associations of Surgeons.— It is customary for railway companies to retain in their service the services of experienced surgeons located at points on their lines, who are expected to be immediately available in case of accident to employees or passengers, some one of them being often designated as Chief Surgeon. In addition to this duty, hygienic questions are submitted to them, and their services are sometimes employed in the examination of men seeking to enter railway service for color blindness or other physical disabilities. They have two organizations, the International Association of Railway Surgeons, with 670 members, formed in 1888, and the American Academy of Railway Surgeons, with 141 members, formed in 1894, and their consolidation is probable. Their objects are the development and improvement of railway surgery, especially by the study and investigation of clinical, medico-legal and sanitary subjects relating thereto.

National Association of Car Service Managers.— For the purpose of supervising the movements of freight cars especially at terminal and junction points, so as to prevent their undue detention in loading or unloading, Car Service Associations, composed of the railway companies centring or connecting at such points have been organized under rules approved by the American Railway Association. Each local organization is in charge of an official called the car service manager. Thirty-nine of these officials organized a national association in 1890 for the purpose of obtaining a general exchange of views as to the best methods of conducting the business and to secure harmony of action.

The Railway Signal Association was organized in 1897, has 355 members, and holds five sessions per year. Its object is the advancement of knowledge concerning the design, construction, maintenance and operation of railway signaling appliances, by discussion, investigation, and reports of experience, for the purpose of systematizing and improving signaling practice. Its membership consists of those persons who are connected with the designing, construction, maintenance or operation of signals. The signal department of railways is one of the youngest and most rapidly developing branches of the service. The subjects considered by its committees are: circuits for automatic block signal systems for steam and electric railroads; for manual block signal systems; for interlocked signals; and for drawbridges; on what shall be considered cost in estimates for installation and records of maintenance; on the use of copper or iron for pole lines; on standards, definitions, nomenclature, office records and accounts.

The American Railway Engineering and Maintenance of Way Association was organized in 1899, has 425 members, and meets annually. Any civil, mechanical or electrical engineer, who has had five years' experience in the location, construction or maintenance of railways, or an official responsible for the maintenance of way, from general manager to division engineer, or whatever may be his title, is eligible for membership. Its working committees are assigned to the following subjects: graduation; ballasting; ties; rail; track; buildings; bridges and trestles; masonry; signs, fences, crossings and cattle guards; signaling and interlocking plants; reports, records and accounts; uniform rules, organization, titles, code, etc.; water service; yards and terminals. One of its purposes is the establishment and maintenance of a library of information concerning maintenance of way matters.

Other national associations of railway officials and employees of the operating department organized for the improvement of the service comprise: Superintendents of bridges and buildings; master boiler makers; master car and locomotive painters; railway air-brake men; master blacksmiths; roadmasters; traveling engineers, dining-car superintendents, and local freight agents. There are also numerous local organizations, such as the Chicago Association of General Superintendents, the Central Association of General Railway Officials, with divisions in Cincinnati, Columbus, Indianapolis, Kansas City, Peoria, Saint Louis and Toledo; the Central and Western, and the Eastern Association of Car Service Officers; Eastern Maintenance of Way Association; Canadian Roadmasters' Association; Buffalo Railroad Association. Railway Clubs, organized for the discussion of technical railway questions, are located at Atlanta, Boston, Buffalo, Chicago, Colorado Springs, Denver, Des Moines, Ia., Macon, Ga., Montreal, New York, Pittsburg, Richmond, Va., Saint Paul, Saint Louis and San Francisco.

The American Association of General Passenger and Ticket Agents, organized 13 March 1855, is the oldest railway organization in America. The ranking officer of the passenger department of each railway corporation and transportation line is eligible to membership. It had 174 members in 1904 and meets annually to discuss matters of general interest to the passenger department. Through this association the American system of interline coupon tickets was introduced, by which passengers are able to purchase tickets from each principal point to all other principal points on the continent. This system has been perfected in North America as in no other country in the world. The association has also prepared standard forms for railroad tickets, and has an organization for the better protection of tickets against alteration, forgery, etc. Formerly the meetings were held to arrange the rates of fares over through routes; but this duty is now performed by local organizations composed of lines operating in separate districts, namely, New England Passenger Association, Trunk Line Passenger Association, Central Passenger Committee, Western Passenger Committee, Trans-Continental Passenger Committee, Southeastern Passenger Committee, etc.

The American Association of Traveling Passenger Agents, organized 17 April 1872, has 867 members and meets annually. Its membership consists of authorized representatives of railway and steam navigation lines, who travel for the purpose of soliciting passenger traffic. Its objects are to suggest such reforms in the railway passenger service as experience may teach to be beneficial to both members and the interests which they represent.

The American Association of General Baggage Agents, organized February 1882, is composed of the general baggage agents of the several transportation lines. It had 67 members in 1904, and meets annually to discuss questions connected with the transportation of baggage, with the view of securing the greatest efficiency, as well as uniformity of practice, in allowance for weight carried free, methods of tracing baggage lost in transit, facilitating its prompt handling, etc.

The Association of American Railway Accounting Officers, organized in 1888, consists of the chiefs and assistants of the various departments of railway accounts. It had 378 members in 1904, representing 223 companies, and meets annually. It is general in its character, rather than a traffic organization. Its objects are the better organization and conduct of the accounts of transportation lines; to aid in securing more perfect means of determining balances between the companies and greater definiteness and promptness in paying the same; greater uniformity in the method of adjusting joint accounts; more equitable plans for settling claims between carriers; greater certainty and promptness in collecting freight charges at competing points; better means of adjusting balances at junctions where freight is rebilled; to obtain greater uniformity, wherever practicable, in the governmental reports required of railroads; and the more general systematization of railway accounts.

The Association of Railway Claim Agents was organized in 1890, has 346 members, and meets annually. It consists of the officers and their assistants who have charge of the investigation of claims for damages (other than freight), their adjustment or defense. Its object is the interchange of experience and the discussion of any subject of interest to railways in the department represented by its membership.

The Freight Claim Association was organized March 1892 by the consolidation of local associations for kindred objects, which had been in existence since 1887. Its membership consists of the general freight or claim agents or other authorized representatives of the general freight or freight claim departments of railroads, transportation lines or companies, including 237 members, representing 181,000 miles of railway. Object: the prompt and equitable settlement of freight claims with claimants and between carriers. This association has formulated a code of rules for the settlement of claims of every variety arising for loss or damage to freight in the handling of traffic. It has an Arbitration Committee which acts as a court for the interpretation of the rules as applied to such questions in dispute as may be referred to it by the parties in interest. W. F. ALLEN.

American Railway Association.

Railway Bridge Designs. See BRIDGE DESIGNS, RAILWAY.

Railway Car Braking.— To ascertain the time when the question of braking first came into prominence we need go no further than the period when highways became sufficiently well made and maintained as to admit of a heavy vehicle being drawn over them at comparatively high speed. Country roads everywhere as late as 1725 were in a most deplorable condition, being narrow and full of ruts and stones. During the middle of the 18th century there was considerable agitation for better roads, which seemed to have a beneficial effect, since during the latter part of this century the first mail coaches, or «Diligences,» were placed upon the roads between London and various cities of Great Britain.

It is a noticeable fact that, with, all kinds of conveyances, the question of braking has increased in importance as the demand for higher speeds increased. During the century from 1770 to 1870 there were granted in England nearly 200 patents for various kinds of braking appliances for common road vehicles; of these 46 were applied to the periphery of the wheel; 28 on the nave, 27 were actuated by the movement of horses, 21 were applied to fly or brake wheels, 8 were applied to the axle, 10 were actuated by a spring, 4 were automatic, 3 electromagnetic, 3 pneumatic, 4 relying on momentum, and 3 accumulated power for subsequent propulsion, etc. In America there had been nearly as many such patents, 21 of which were for automatic designs.

In connection with common road vehicles it is noted that the first devices adopted are those which have formed the basis of almost all brake appliances which have since been employed for the same kind of vehicle. The early stage coaches and even the later mail coaches were provided with an iron shoe which slips under the wheel and is chained to the fore part of the coach, so as to drag both shoe and wheel along over the surface of the ground. This method of braking was one of the first devices adopted, and is used extensively to-day. The old arrangements of two brake blocks and a beam with suitable levers connecting each to the driver was also early introduced, and all kinds of developments from this arrangement are seen to-day on various kinds of vehicles.

Many primitive forms of brakes were applied to such railroads as existed, but the speeds employed on these roads were generally low and the cars small enough to be drawn by draught animals, and the question was not a particularly serious one until the advent of the steam locomotive. The great revolution which the knowledge of the power and use of steam has brought about was well under way during the first part of the 19th century. During the first 70 years of the century about 650 patents were granted in England for various kinds of brakes for railroad service. In 1833, Stevenson patented his steam brake, consisting simply of a small cylinder containing a piston, the rod of which connected through a system of levers to a cam brake. The first pneumatic brake was a vacuum brake, patented by James Nasmyth and Charles May in 1844. In 1848 Samuel C. Lister patented an air brake, having an axle-driven pump and suitable reservoir to be placed on the «guard's carriage,» and suitable cylinder, pipe and connections on the various cars to constitute a straight-air equipment.

Many interesting and ingenious contrivances were suggested and patents obtained for same in the United States. The «Cramer» brake, which was brought into use in 1853, consisted of a large spiral spring attached to the brake staff at the end of the car, and which was wound up by the brakeman immediately after leaving a station. The «Loughridge chain brake,» which came into use in 1855, consisted of a system of rods and chains continuously connected throughout the train. These types were the results of much research. There were many other forms of brake which attained a certain degree of prominence, and were more or less successfully operated upon different roads throughout the country.

In 1869, the Westinghouse non-automatic air brake, which has since generally been designated as the "straight air" brake, was brought out. It consisted of a simple steam-actuated air pump placed upon the side of the engine, and a reservoir in which the compressed air could be stored. A pipe line from the reservoir was carried throughout the length of the train, connections between vehicles being made by means of hose and couplings. Each vehicle was provided with a simple cast-iron cylinder, the piston rod of which was connected to the brake rigging in such a way that when the air was admitted to the cylinder the piston was forced out and the brakes thereby applied. In the engineer's cab there was placed in the pipe line a three-way cock, by means of which compressed air could be admitted to the train pipe, and thus to the cylinders on each car; or the air already in the cylinders and train pipe could be discharged to the atmosphere, thus releasing the brakes.

This was the simplest and most efficient brake that had been introduced up to that time, and was largely adopted by American railways; but while all that could be desired for single vehicles, the danger incident to the entire loss of braking power when most needed, due to the bursting of hose under pressure, the parting of the train or other rupture of the brake system, led to the invention of the automatic brake. The first form of this brake was introduced in 1872, and is now generally referred to as the «plain automatic.» The essential difference between this brake and the «straight-air» type, which it superseded, consisted in the installation of supplementary or auxiliary reservoirs for the storage of compressed air on the cars in addition to the main reservoir on the locomotive, so that each vehicle carried its own supply, and the employment of a most ingenious valve mechanism, by means of which the application of the brake was caused by the reduction of air pressure in the train pipe, whether such reduction was made intentionally or as the result of accident.

The original three-way cock in the engineer's cab has been lately replaced by a more elaborate valve known as an engineer's brake valve. The necessity for this substitution was due to the fact that in applying the brakes the reduction of pressure in the trainpipe had to be more carefully made than was practicable with an ordinary three-waycock. The brake valve was arranged so that in releasing the brakes, air was allowed to flow from the main reservoir on the engine into the trainpipe and auxiliary reservoirs. The engineer by moving the handle to the application position connected the trainpipe to the atmosphere through very carefully graduated openings, and the pressure gauge connected to the trainpipe showed how much reduction was made, and indicated, therefore, the amount of air that would flow from the auxiliary reservoirs into the brake cylinders.

The immense advantage to railway companies along the line of higher speed, greater safety and pronounced economy in the substitution of a reliable automatic power brake under the control of the engineer for the old hand brake was soon recognized, and the work of making this change proceeded rapidly throughout the entire country. Naturally enough, the new conditions encountered brought to light new problems, the solution of which enlisted the best efforts of railway officials and brake manufacturers alike. In many instances it was found that the only possible way to determine the questions involved with any degree of satisfaction was by means of practical tests made under conditions found in actual service.

Very recently, the greatly increased speed of all classes of passenger service, coupled with the demonstration that in order to approach a uniform rate of retardation it was necessary to have a much higher brake-shoe pressure for high speeds than for low, rendered imperative the «high-speed brake.» This apparatus consists of the quick-action automatic brake, with the addition of an automatic reducing valve connected to the brake cylinder. The normal train pipe and auxiliary reservoir pressures are raised from 70 pounds (the ordinary quick-action pressure) to 110 pounds. The reducing valve is arranged so that in service applications the brake cylinder pressure cannot exceed 60 pounds, but in emergency application the initial cylinder pressure becomes nearly 90 pounds, which i. gradually reduced as the speed decreases, until 60 pounds is reached, which pressure is retained until released by the engineer. This high-speed brake has reduced the distance within which a train can be stopped by at least 30 per cent. See RAILROAD SYSTEMS.

EDWARD S. FARROW,
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Railway Car Cleaning. From the early days of railroading until the present time constant attention has been given to the requirements of sanitation of passenger cars, and how best to insure cleanliness has been a problem with no easy solution. The old method of car cleaning with a whisk here and a dash there with a broom or duster, was not only unsanitary, but unsatisfactory for the reason that it had the effect largely of removing dust and dirt from one section, and depositing it elsewhere; but under the latest and most highly approved method, which is termed the «Vacuum Sweeping System,» the dirt and dust are drawn from the car by suction through a pipe.

Prominent railroads have recently erected immense vacuum plants in their car yards, and for distances of several thousand feet have laid pipes varying from two to five inches in diameter. At short intervals this pipe is tapped and from these cocks is run the flexible hose, which may be taken in the car, either by door or window. At the foot of the hose is a metal pipe with a flat triangular end, along the base of which is an opening, and through which the dust and dirt are drawn by the vacuum or «drawing-in machine» located a distance away. The operator runs the slot opening over the cushions, carpets, curtains, woodwork, etc., and without any commotion or dust raising, every loose particle or germ is whisked away, everything being left clean and wholesome. The dust thus removed, before reaching the «drawing-in machine,» passes through two dust separators, the first of which clears the air of 90 per cent of the grit, dust and germs; the second separator or cylinder draws the air through water in which corrosive sublimate is used, and completes perfectly the purification. Railroad managers have for a long time felt the necessity for a more sanitary method of car cleaning, and the vacuum system, while reducing disease liabilities to a minimum, at the same time reduces the cost of cleaning and time consumed. Two cars can be thoroughly cleaned under the new system at the same expense of time and money as was formerly consumed in cleaning one.

The only valid objection to the vacuum system is the cutting out the pyle of the plush very much more rapidly than the process of hand beating, there being more or less sand in the cars. In Jersey City, where perhaps the largest number of cars are cleaned, the other methods in vogue are essentially as follows: (1) The carpets are removed by rolling them in bundles, and then taking to the cleaning shed. (2) The seats, cushions, pillows, mattresses, and blankets are removed to a shed alongside the car, where they are beaten, dusted, and aired. (3) Men go through the car and dust all portions, including the upper berths, with feather dusters, immediately after which the upper berths are closed. (4) The charwomen wash the woodwork and glass with lukewarm water and castile soap. The rugs, particularly those of the smoking compartments, are, if badly soiled, washed with soap and water and then dried. The cars cleaned in Washington and Jersey City are treated in this way every other trip, being only swept at the end of each run.

This vacuum cleaning process has of late been successfully applied in the New York Subway, where it has been demonstrated that a suitable car fitted with a plant can clean one of the stations in less than half an hour, and that while running between stations it can take up the loose dirt from the roadbed and dump it in the yard at the terminal after all the stations have been swept.

Railway Consolidation. The consolidation — or as the English say, the amalgamation — of railways consists either (*a*) in uniting connecting lines into one continuous line, or (*b*) in uniting parallel or competing lines into a system. Railways in the United States were originally built for the most part in short, disassociated lines — little stretches of road from A town to B town. Construction had progressed only a little before the desirability of connection between these lines became obvious. And almost at once such connection began to be arranged, so that, in the progress of our railway building and some time prior to about 1870, a great number of these little lines in every part of the country had been amalgamated, with the result of developing our great trunk line systems. Before we had entered upon the last quarter of the 19th century, it had come to pass, speaking generally, as a result of this tendency to unite connecting lines, that very much the greater and more important part of our railway system consisted of long lines of road under a single management or control, made up, especially in the older parts of the country, of a less or greater number of formerly disconnected and independent local lines, which had been one after the other taken over and incorporated into the greater continuous line or system. Almost all the valuable and well located local lines had, 30 years or more ago, thus been absorbed into larger and less local combinations. Such consolidation, working only benefit to the public and demonstrating its usefulness as it went along, provoked only a small amount of opposition, and these amalgamations of connecting lines usually secured legal sanction, whenever necessary, without the protest of the politicians. But about 1870 — now a full generation ago — a tendency in the direction of the consolidation of parallel and competing lines developed. What had long been known in Europe to be the true law of railway construction, and the sound basis upon which railways must ultimately come to exist and be operated in every country where there is enough wealth and commercial activity to make them successful — namely a division of territory and the practical elimination of competition between parallel lines in the same territory — began to assert itself and to be felt to be applicable here: and directly we entered upon a period of consolidation, not now of connecting but of competing lines; and, summing up the whole matter in a single sentence, that process of amalgamation, having now gone on in this country for nearly 40 years, it results that we are now at the end substantially, of the second stage of railway combination.

First, we built isolated and disconnected local lines; second, we united these connecting lines — whenever they did connect — into continuous lines; and third, we divided up the territory between theretofore competing lines, by gradually amalgamating either the ownership or the control of such lines in a defined territory, thus securing little by little to a single interest, a territorial monopoly of the carrying services of the locality. This process carried out to its logical conclusion roughly divides the whole country into railway territories of greater or less extent, within each of which one single railway system is paramount or absolutely controlling. This readjustment of ownership and control between the greater railway companies of the country goes steadily on. In some sections of the country it seems to have been fully and finally accomplished; in other sections it is in progress; and only where the game isn't worth the candle or where the work has been done, is there an absence of activity in this direction, the tendency so to consolidate, first connecting and then competing lines, has been universal and inevitable, and such consolidation is in the one case an accomplished fact and in the other an irresistible evolution. Very little effort was made to prevent the earlier consolidations, that of merely connecting lines. It is now well understood that such efforts, if they had been made, would have failed, and it is now not questioned that such consolidations have been beneficial both to the public and the railways. On the other hand a very great deal of effort has been made by courts and statutes to prevent and hinder the second form of consolidation, that of competing or parallel lines. These efforts have also for the most part failed, and it is now coming more and more to be believed that they will ultimately wholly fail to prevent what seems to be the inevitable in railway development. Moreover, in the case of the amalgamation of connecting lines, the mischiefs which have been apprehended have generally not been realized; so that now not only most practical railway men, but many students of the railway problem believe that in the outcome the balance of benefit both to the carrier and to the public will be also found on the side of territorial division between competing lines.

The history of railway construction and combination throughout the world seems to indicate *first* that the consolidation of competing lines is inevitable; *second*, that efforts by legislation or litigation to prevent it always fail;

and *third,* that such consolidations benefit both the public and the railways. The facts and figures concerning these consolidations in the United States are detailed elsewhere in this work, but the economic questions involved are still open ones with us. Elsewhere throughout the world these questions seem to be settled. Thus in England, where the railway problem has in many of its features been strikingly like our own, the question is now quite at rest. In France the question never really arose, and elsewhere in Europe it has been decided everywhere in favor of amalgamation and against the continuation of competition between lines serving the same territory. (The writer's argument in the Supreme Court of the United States, October Term, 1903, upon the appeal of The Northern Securities Company *et al* v. the United States.)

England.—In February 1872, a Select Joint Committee on Railway Companies Amalgamation was appointed by the two Houses of the English Parliament to investigate and report back the condition of the railways of Great Britain, particularly in respect of the consolidation of lines and the division of territory among the greater companies. Mr. Chichester Fortescue, in moving the appointment of the Select Committee in the House of Commons, on 23 Feb. 1872, said that «twenty years ago a Committee had reported against the system of amalgamation, but since that committee reported amalgamation had gone on as merrily as before — the fact being that 5,000 miles of railway had been added to the greater railways since that time.»

This committee called a great number of witnesses and went fully into the details of the matter throughout the British Islands, and on 2 Aug. 1872, presented a voluminous report, from which it appeared that by the end of the year 1843, 71 separate and independent lines had been constructed, averaging about 30 miles each in length. During the following year the average mileage per independent line was reduced one half, so that by the end of the year 1844 the average was only about 15 miles. Between 1844 and 1847, 637 separate companies had been chartered, with a total authorized length of about 9,400 miles of line. Eleven proposals, for example, were made to Parliament for lines of railway through a single narrow valley, where but one line was possible. This called so loudly for relief that consolidation began about 1847, and so proceeded, by the gradual absorption of the smaller lines by the larger systems, and by a consequent division of territory between the consolidated companies, that by 1872 it had come to pass that the railway business of the Kingdom was substantially performed by no more than about six of these great amalgamated companies. The first English railway charters contained provisions intended to prevent competition both between the lines themselves and between them and the canals, especially in freight traffic. George Stephenson, the father of English railways, seems to have appreciated clearly the mischief to be avoided in the matter of competition, even at that early day, and he, therefore, set himself to the task of getting the railway system in that country started right in this particular. His view on this subject was summed up in his much-quoted saying that «where combination is possible, competition is impossible.»

In 1836, a Mr. Morrison, M. P., from Inverness, made a remarkable speech in Parliament, in the course of a discussion of the then English railway situation, in which he pointed out with uttermost clearness that a railway must in the nature of things be a monopoly; that competing roads will inevitably combine; that parallel lines are sheer waste of capital, and that fixed maximum rates are useless. This utterance is the more remarkable because it stated clearly, at the outset of railway building and before there was any basis of fact and experience upon which to found such generalization, the ultimate principles which long experience has since demonstrated to be sound.

Thus it is seen that the English railways started right, but that they soon got wrong, and for the first 30 years and more, blunders in plenty were made in futile endeavors to construct and operate railways on the principle of intercompetition. Uncounted treasure was wasted in these attempts, and absolutely nothing but experience was gained by it. By 1872 competition had been substantially eliminated through the operation of natural laws and in spite of hostile legislation and litigation. It was said in Parliament, in the debates over the appointment of the Select Committee in 1872, that there was not at that time a single competitive rate existing in the Kingdom. With the legislation of 1873 the general railway situation in England was fixed and determined, and the agitation for competition ended. The railways ceased to be bugbears, and fears of mischief to the public from the growth of railway influence and power gave place to intelligent criticism of railway methods and to a public-spirited determination to get good service at fair rates while giving the companies a free hand to manage their finances in their own way. Thus, after nearly 40 years of experiment, agitation and disturbances, the English people came back about 1872 to their point of commencement. Mr. Adams, in his 'Railroads and Railroad Questions,' says that then England «settled down on the doctrine of *laissez faire*»; and President Hadley, in his 'Railroad Transportation,' says «It might better be said that it has settled down on the policy of specific laws for specific troubles.» By about 1872, as we thus see, the problem was solved by the operation of immutable economic laws, and the decision against competition between lines made beyond all possibility of reversion. To make a summary statement it appears that in 1847 there were about 5,000 miles of railway in England, owned and operated by several hundred independent and competing companies; 25 years later there were 13,000 miles of railway, owned and operated by 12 partly competing companies; now there are a little over 15,000 miles, owned and operated by about six non-competing companies.

The history of some of the greater English companies taken a little in detail illustrates the situation. The London & North-Western Railway was first opened for traffic in 1837, about a month after the accession of Queen Victoria. In 1846, it consisted of a main line from London to Birmingham, with some insignificant branches. In 1852, a writer on the position of the company complains that it "fell a few years back into the error generally committed by railway companies of amalgamation with numerous other railway companies. From being a line from London to Birmingham, 112½ miles, it has become a line or lines of 539½ miles long — five times its original length." Since that time it has increased its mileage nearly four-fold, and has merged into its system the Chester and Holyhead lines on the west and the Lancashire and Carlisle on the north, besides numerous smaller undertakings too numerous to mention. The Great Western Railway has been absorbing smaller independent lines in its territory for many years, and altogether considerably more than 100 have been so absorbed within the last 40 years. Since 1896 it has taken over about 20 such lines, adding thereby 260 miles to its system. Of its total capital expenditure from 1892 to 1901, amounting to about 15½ millions sterling, nearly 5 millions represented amalgamations. The North-Eastern Railway is a consolidation of various small lines which has resulted in a vast network of railway in the northeast of England without a single intruder in the territory in the shape of a competitor. The report of the Select Committee on Railway Amalgamation in 1872 contained the following reference to this line:

> The case of the North-Eastern is a striking illustration. That railway or system of railways is composed of 37 lines, several of which formerly competed with each other. Before their amalgamation they had, generally speaking, high rates and fares, and low dividends. The system is now the most complete monopoly in the United Kingdom; from the Tyne to the Humber with one local exception, it has the county to itself, and it has the lowest fares, and the highest dividend of any large English railway. It has had little or no litigation with other companies. While complaints have been heard from Lancashire and Yorkshire, where there are so-called competing lines, no witness has appeared to complain of the North-Eastern; and the general feeling in the district it serves appears favorable to its management.

The Great Central Railway, which was opened for all classes of traffic in April 1899, has a total mileage of 665 miles. Of this mileage 465 belongs to it and 200 are jointly owned with other companies. In addition, the company owns 111 miles of canals and tramways. It is, therefore, a system essentially made up of joint lines and canals. It is also the newest line in England, and may stand for the most recent type of development in that country.

It now seems certain that in no very long time all intramural transit in London which is wholly or partly underground, aggregating nearly 225 miles in length, will be consolidated into no more than two great substantially non-competing enterprises, dividing the territory in a way between them, upon a line (roughly speaking) which runs northwest and southeast through Piccadilly Circus, or dividing, along non-competitive lines as much as possible, about Piccadilly Circus and converging severally therein. The Joint Parliamentary Committee of 1901 reported that it was desirable that the working of underground railways in and around London should be put under the control of some one consolidated interest; and if we read into the future of these underground lines the railway experience of the past in England above ground, that is sure to be the ultimate solution.

The English courts commenced, about the middle of the last century, to break down the old common law doctrines theretofore in vogue against monopolies, which were invoked in opposition to railway consolidation. Gradually the whole legal theory upon which those doctrines were attempted to be sustained has been overthrown, until now there is in England no legal objection possible to be urged, and very little popular prejudice to the amalgamation of railway lines whenever and wherever it seems to be economically desirable. The legal arguments against these consolidations were always drawn from the old decisions against monopolies and restraint of trade, which more than 50 years ago began to be repudiated *in toto* by the English judges. Thus in a leading case often referred to, which was decided in the House of Lords about 1850, Lord St. Leonards used the following notable language:

> My Lords, there are just a few remarks that I wish to make upon public policy. I will not add a word to what has been already said by my noble and learned friends, but I will call your attention to what fell from one of the learned judges (Mr. Justice Cresswell) as regards the restraint of trade. That learned judge says that with regard to the restraint of trade, there is a maxim in common law, and he refers to a case in Year Books (2 Hen. V., pl. 26); to prove it; but the learned judge did not tell your lordships upon what that maxim was founded. Nobody supposes that there was any statute upon the subject in those times. Upon what, then, was that maxim founded? Why, upon public policy for the good of the realm. It was not good for the realm that men should be prevented from exercising their trades. Now, let us see what this particular case is; it lies in few words and remarkable consequences have resulted from it. It was an obligation with a condition that if a man did not exercise his craft of a dyer, within a certain town, that is, where he carried on his business, for six months, then the obligation was to be void, and it was averred that he had used his art there within the time limited, upon which Mr. Justice Hull, being uncommonly angry at such a violation of all law, said, according to the book, "Per Dieu, if he were here, to prison he should go until he made fine to the king, because he had dared to restrain the liberty of the subject." I wish to draw your lordships' attention to this case. Angry as the learned judge was at that infraction of the law, what has been the result of that very rule without any statute intervening? That the common law, as it is called, has adapted itself, upon grounds of public policy, to a totally different and limited rule that would guide us at this day, and the condition which was then so strongly denounced is just as good a condition now as any that was ever inserted in a contract, because a partial restraint, created in that way, with a particular object, is now perfectly legal. Without any exclamation of the judge, and without any danger of prison, any subject of this realm may sue upon such a condition as Mr. Justice Hull was so very indignant at in that particular case. That shows, therefore, that the rule which the learned judge, whose opinion is now before the House, thought depended upon some rule of common law, regardless of policy, was founded upon public policy, and has been restrained and limited and qualified up to this very hour, and beneficially so, by that very policy which it is supposed had no bearing at all upon the foundation of the rule. (*Egerton v. Earl Brownlow,* 4 H. L. Cas., 1, 237, 238.)

Within the last five years the notable consolidation of the London, Chatham & Dover and the London & South-Eastern lines has been effected, which operates to merge two theretofore independent parallel and competing lines and to allot the whole southeastern section of England to the amalgamated company. This, as is usual in that country, was accomplished through special Parliamentary powers, which in this case were sought and obtained without arousing any great opposition, engendering any considerable heat, or provoking any declamation about a sacrifice of the rights of the public

In point of fact, nothing but good seems to have flowed from it.

Previous to 1899 both these railways had achieved an unenviable notoriety for the inadequacy, slowness, and unpunctuality of their services, for the dilapidated condition of their stations and rolling stock, and generally for the backward state of their accommodation. In the case of the Chatham Company the financial position was also precarious, and though the South-Eastern at one time was nominally much stronger in this respect, it too had lost much ground in the preceding five years, and for 1901 its ordinary dividend at the rate of only 2 per cent was the worst in its history. Competition of the worst kind between the South-Eastern and Chatham companies was a normal state of affairs, and as the result both railways spent vast sums of capital and revenue for which there is at the present time little to show except duplicate lines and stations, and inadequate provision for traffic where extended accommodation was most required. Many times a fusion of interests had been urged upon the two companies, but without result. Negotiations for amalgamation were entered upon several times, but they always broke down at the crucial moment.

At last, in 1898, an agreement between the two companies was come to, not for a complete amalgamation, but for the pooling of gross revenue and working expenses and the division of net profits on a fixed percentage basis, with additional arrangements for the joint contribution of capital required. It was not the intention of the two companies to seek Parliamentary authority for this arrangement, as they were not bound to secure the sanction of any other body than their shareholders. But the government virtually intimated that the new arrangement was so important and far-reaching in its bearing on the interests of the public, that the terms of agreement ought to be embodied in a bill. This bill received the royal assent on 1 Aug. 1899, and seven months thereafter the new arrangement came into operation.

The preamble of the bill recites that

> With a view to avoiding undue competition and unnecessary expense and delays and other inconveniences arising from diversity of interests and to turning to the best account the respective powers and resources of the two companies . . . it is expedient and will be for the public advantage that, subject to the provisions and enactments in this Act contained, the undertakings of the two companies should be used, worked, managed, maintained, and improved from and after the passing of this Act, as one undertaking . . . .

The Act constituted a Managing Committee to administer the two railways as one company, that new body being made up of the directors of the two companies.

The committee of 1872 sum up their view upon the effect of hostile or prohibitory legislation on this subject as follows: "A long and varied experience has fully demonstrated the fact that, while Parliament may hinder and thwart it, it cannot prevent it." The theory of the British Constitution is that Parliament is omnipotent, and here there is formal admission that there are things that omnipotence cannot do.

France.—The French railway system was developed a little later than the English, but we must look as far back as the reign of Louis XI., in the latter part of the 15th century, if we are fully to understand and appreciate that development. That sagacious and masterful prince, who reigned from 1461 to 1483, broke effectually the power of the great feudatories, and by a consolidation of authority in the crown laid the foundation of the absolute monarchy. His taking the postal service out of the hands of the feudal authorities and away from the cities and making it a matter of national administration, these 400 years ago and more, was one of the most notable acts of his reign, and was in a way the first step toward the modern railway system of France. "Modern history," says President Hadley, in speaking of the nationalization of the French post-office, "— the history of nations as such — may almost be said to have begun at this point." What Louis XI. did for the power of the crown and for the postal service of the country, Louis XIV. and Colbert did in laying the foundation of the national system of highroads and canals. The Ecole des Ponts et Chaussés was founded, and trained engineers graduated therefrom laid out, constructed and perfected that splendid system of canals and highways, radiating from Paris and reaching every corner of the kingdom, which long ago made France the first country in the world in its roads and waterways. There was from the beginning complete organization, intelligent survey and construction and strict supervision; so that an almost perfect system of lines of communication existed in France before railways were known. In no other country had such results been accomplished in road-making, and nowhere else was such completeness of organization and development possible. The genius of highways had in some sort come down to France as an inheritance from Rome, whose military roads were one of her most characteristic monuments. In this state of case, with a perfect system of roads and canals already built and in operation — which made railways seem less necessary in France than in other countries — it is not strange that the French built railways slowly and cautiously. So it was not merely accidental that France moved tardily in this matter. It is not in the French character to make radical changes, or to do things piecemeal; and it was easy for her highway engineers to see that other nations were blundering in their first railway construction. The racial qualities that distinguish the French, their spirit of order and economy, their notion of proportion, and their conservative good sense in business, all had something to do with their making haste slowly in railway building. It is very much the French way to let other people make the initial experiments in new things, and only to take a thing up when it is demonstrably sound and feasible. It is almost a racial instinct, and this is what happened in the development of French railways. The result is that they now possess the only railway system in the world which was intelligently conceived from the outset as a unit, which was scientifically planned and laid down by competent engineers working together to a common end, and which was built as a whole. The conditions in France that made this possible had their genesis in the dominating sagacity and spirit of order of Louis XI. The highways and canals led up to the railway lines, and the governmental regulation and control of the old land and waterways grew naturally into the present system of railway supervision. The system of roads and waterways existing in 1830 suited the French nation exactly. They were so arranged and classified that each bore its exact proportion of importance, whether national, departmental or local. They were regulated from Paris with ease and with military precision. Never was there so efficient a corps of engineers for carrying out such a scheme as that which is trained at the Ecole des Ponts et Chaussées. The first step taken by the government looking to a general railway system was the appropriation of a sum of money to pay the government engineers for laying out a general system of railway lines covering the whole of France. When this survey was completed, and while the lines existed only on the maps and blue-prints of the engineers, the government next took up the question of ownership and management. While other countries had been acting and experimenting and making costly mistakes, France had been reasoning and thinking the matter out. There was a long series of debates in Parliament between 1837 and 1840. The plan finally adopted was the conception of Thiers, and was settled upon in 1842. The plans then and thus deliberately conceived and matured — both of engineering and of legislation — have since been carried out consistently. They were sufficiently elastic to be practicable. It was at the outset a policy of support and control without actual ownership, or, in other words, a policy of subsidies to encourage private companies, and in return for these subsidies a reservation of more or less important rights of state control. As the work proceeded and as new conditions arose, amendments and modifications were incorporated into the plan as originally conceived. In 1842 it was strictly a plan for subsidies; in 1852, extensions of chartered privileges were granted to the companies; in 1859, a scheme for the guarantee of interest on the bonds was inaugurated, and, in 1883, the government guarantee was extended to dividends.

Under the plan adopted 33 different companies were chartered, contemplating about 2,500 miles of line. Building went on rapidly until the revolution of 1848, and then again after the accession of Napoleon III, in 1851. The lines have from the beginning been laid down with the idea of avoiding all duplication and all waste of capital; they were surveyed and traced by government engineers, and each part stood in its proper and intelligent relation to the whole. Parallel lines were forbidden as a matter of course, and competition was not conceived of as among the possibilities of the situation. By 1852 the number of independent systems had been reduced from 33 to 11, and in 1859 the 11 were reduced to 6, of which 5 radiated from Paris. Each had a monopoly in its own territory. Competition running riot, the construction of needless lines as a mere speculation in the securities, rate wars, with their attendant iniquities, and the consequent wanton waste of money and effort in construction and operation are essentially unthinkable to a French railway engineer or official. New construction is undertaken only as required, and to meet the necessities for more lines growing out of the development of any particular territory. About 1859 it became obvious that a considerable amount of new construction was necessary in order to bring the railway system up to a proper standard of utility and efficiency, and in order to secure this construction, each of the six companies, and each in its own district, undertook to construct a large number of branch lines. The government took the initiative, and in order to facilitate this new work and to secure it promptly recourse was had to a system of state guarantees of interest on the bonds upon which the money for the new construction was to be raised. This was the plan devised by De Franqueville. Money was, of course, easily raised by issues of bonds upon which the government guaranteed 4 per cent, this guarantee making the securities instantly marketable and extremely valuable. There was, accordingly, no wasteful financiering, no iniquitous jobs, no lack of funds, no foreclosures, no reorganizations, receiverships or squeezing of investors. In 1865 a further plan was proposed in the Chamber for the construction of a network of local roads not to belong to the six companies, and the municipal authorities were given the right to subsidize such lines. Pursuant to this plan, several thousand miles of these local lines were built throughout the country within the next five years. It was not, however, contemplated that they should be combined into systems which might interfere in any way with the monopoly of the six companies. They were designed to be feeders. However, after the war of 1871, the prohibition to combine was successfully evaded, and these local lines by a series of combinations began to be serious competitors in many places to the main systems. This made it necessary for the government to take the matter again in hand, and the problem was ultimately solved by having the great companies take over the local lines within their territories severally, upon terms. In 1879, by a decree of July of that year in the Chamber of Deputies, De Freycinet undertook to raise a loan of 3,000,000,000 francs for the construction of about 10,000 miles of additional line. This plan has been slowly carried out since that time. There was at first some delay, but by the beginning of 1884 this last comprehensive scheme of railway development was settled upon, the leading points of which were these: first, that the state hereafter should confine its own railway operations to the small district in the southwest occupied by what is known as the state line; that isolated lines which the state owned in various parts of the country should be taken over by that one of the six great companies in whose territory it lay; second, that additional lines as needed should in future be constructed only by the companies in whose district they belong; third, that the state should guarantee each company a minimum dividend, and that when the amount available for dividends exceeded a certain percentage — the rate differing for each line — two thirds of the excess should go to the state. The limit, however, was placed so high that this provision has been practically inoperative. Thus, for example, on the Northern line, the guarantee minimum dividend is 13.5 per cent, while the point beyond which the state shares the excess is 22.1 per cent. In the case of the Paris, Lyons & Mediterranean, the guarantee minimum is 11 per cent, the state sharing in anything beyond

15 per cent, and so on, with slightly lower percentages for the other companies.

All of the lines in France with one exception are owned and operated by private companies. They are *concédés* and become state property upon the expiration of the concessions. Meantime they are subject to a strict governmental supervision and control. The length open for traffic on 31 Dec. 1901, was 23,880 miles, which fully meets all the requirements of the country. The original scheme was for the government to contribute about 250,000 francs per mile; and private enterprise to find about 200,000 francs per mile, thus dividing the expense and the ownership. The concessions generally were to fall in, first in about 40 and later on in 99 years. When this occurs — about the middle of the present century — the government will, it is claimed, become possessed of an asset in the shape of railway property sufficient in realizable value to pay off in full the national debt. In 1892 the French railways were conservatively valued at 16,000,000,000 francs. The original plans of construction and joint ownership were somewhat modified as time ran on. In the construction of the French lines there has been less waste of capital and better results for capital than elsewhere in the world. French railways have cost less and come to more than any others on earth. It need not be argued that the French scheme put in practice would inevitably reduce the cost of construction to a minimum and would secure the best results for the least money. Passing by the matter of the state guarantee of interest and dividends, it may be said that the net earnings of the six private companies have been upon an average far beyond anything accomplished elsewhere in the world in that respect from railway operation. Furthermore, in face of the strong position of the French railways as monopolies, the government notwithstanding exercises a sufficient control — one which is in many respects admirable. No other country has in its civil service such a body of trained engineers and inspectors, and nowhere else are things done so well along these lines as in France. The French plan, as is seen, forces the numerous independent companies to work in harmony with one another, while giving each of them an absolute monopoly in their own territory. It renders, therefore, the process of consolidation within that territory easy and inevitable. Whatever slight attempts have been made in the Chamber to check or prevent combination or monopoly have been promptly overruled as contrary to the general scheme. This was particularly the case in 1875, when Phillippart, a Belgium capitalist, undertook to consolidate the local lines as against the six companies; and even the state itself in the operation of its own lines in the southwest has never succeeded in breaking into the monopoly of the Orleans Company in that territory. While France prohibits effectively competition between her railway lines, she is constantly spending large sums in improving internal water communication; and private carriers using these waterways without paying any toll carry off more or less traffic from the railways, and are allowed to do so. To make a summary statement, we find the facts to be that in France the railway system was intelligently planned as a unit from the outset; that the lines were laid down by competent government engineers and constructed without paralleling; that in consequence very little money was wasted in construction; that competition did not enter into the scheme as originally devised, and that when it arose — notably through the consolidations of the network of local lines built between 1865 and 1870 — it was suppressed by the government; that railway investments have been almost uniformly profitable, and upon the whole much more profitable than in other countries; that freight rates are not excessive and that passenger rates are very low; that the public is well served, the passenger service especially being of the very best; that governmental regulation is not hampered or thwarted by the strength of the railways as monopolies; that no mischief and much good seems to have come from the elimination of competition between lines, and that upon the whole the French scheme secures a maximum of adequate, efficient and satisfactory service at a minimum of cost and friction.

Belgium.— The policy of government ownership is perhaps best typified by the Belgian system. Of all countries in the world Belgium probably offered the best field for a state railroad. The country is small, compact and rich, the population crowded, active and intelligent, and the industries varied, all which insured a large volume of local traffic. Moreover, Belgium is on the highway between England and Germany, so that, in addition to a dense local traffic, the Belgian lines were certain to secure considerable through traffic on commodities moving between England and Germany. There was in consequence of all this little room for mistake in locating the main lines, and they were, as in France, for the most part laid down intelligently and built economically. Railway construction began as early as 1833. Private companies were allowed to build lines wherever the state did not choose to build, but competition between the lines owned by private companies and the state lines was not at any time part of the original scheme. Like the French, the Belgians saw from the start that competition would be uneconomic and wasteful. The private railways increased rapidly from 200 miles in 1850 to 700 miles in 1860, and 1,400 miles in 1870. This rapid growth of the private lines was accompanied by their inevitable consolidation into systems, and in spite of the fact that competition had not been contemplated, there began in Belgium about 1856 a period of railway war between the state and the private lines and among the private lines themselves. Theoretically, the state had and exercised the power to forbid the private companies from entering into any competition with the state lines, but, in spite of that, competition in Belgium after about 1856-7 was keen. The state had the better routes and in some sort the inside track, but some other advantages possessed by the private companies practically offset this advantage. This competition working the usual mischief finally drove the government to the expedient of buying out the private companies. This began about 1870. By 1874 the government owned more than half the mileage of the country. By 1880, it owned two thirds, and in 1902, there were 2,516 miles of railway in the country, all or practically all, of which is controlled by the state, either through ownership or lease, and competition is in consequence wholly eliminated. The state now owns more than 70 per cent of the total mileage, and operates almost all of the remaining 30 per cent by lease. This is in brief the history of the development of railways in Belgium. It appears that competition was not part of the original scheme; that it nevertheless arose and ran its course; that when the state realized the disadvantage of it, steps were taken to eliminate it entirely, and that this was done by the purchase of the competitive lines. There was at first the inevitable consolidation of the private lines, eliminating competition between those lines themselves, but intensifying it as between them and the government lines. Then came the consolidation of these lines with the state-owned lines by government purchase, and competition was at an end. It is another case of the universal tendency to combine, and of the powerlessness of government to prevent it.

Italy.—In 1878, a Parliamentary commission in Italy undertook an investigation of the railway situation in that country. Testimony was taken throughout the kingdom, and an enormous mass of material collected. In 1881, this commission made its report to the government, which was subsequently published in seven quarto volumes. It was the most thorough railway investigation ever undertaken in the world, and the report is probably the most valuable in existence. The material parts of it have been translated into French, and are thus available. From the work of this commission it appears that, prior to the wars which resulted in the union of the Italian states in 1870, the principal railway lines of Italy not only were disconnected and independent of each other, but also constituted isolated or strictly local systems for each of the chief independent states. Thus the lines in Tuscany, in Lombardy, and in Piedmont were wholly distinct both from one another, and also from those centring in Venice, Rome and Naples. Some of the early charters had come from the Emperor of Austria and one from the Pope: the lines were inadequate to the demands of the business of the country, the service was very poor and the companies substantially bankrupt and irresponsible, but there was plenty of competition. The problem after 1870 was to unite and consolidate these scattered and local lines into systems fit for united Italy, to construct new lines, to reconstruct old ones, to reequip and to reconstitute; and then to operate the reconstructed lines as a whole. The range of mountains from north to south which constitutes the back-bone of the Italian peninsula dictated a natural division of territory for the amalgamated lines. There was as of course much local jealousy to overcome. Although Italy was too poor to spend much money in experiments, there was thought to be danger to the autonomy of the new state in permitting foreign capital to come into the railways, and it was prevented by the government, so that, in consequence of all these matters and hindrances, things at first moved slowly. Connecting links were first built, which served to unite the isolated local systems, the plan being to consolidate the local parallel and competing lines rather than the connecting lines. Finally the roads fell into four systems—that of Upper Italy, that of Rome, that of the east coast, and that of Sicily and the south. Here, as elsewhere in Europe, competition between parallel lines did not enter into the scheme of construction and reconstruction, and consequently consolidation was not only inevitable but easy, and it was facilitated wherever there was duplication. Upon the division of territory between the four systems, and with the consolidation of lines within those four territories respectively and the building of the connecting links, the problem of construction was in a way to be solved; or, in other words, the lines were laid down and ready for operation. Next came the problem of ultimate ownership and present maintenance and operation. Soon after 1870 the state had begun to buy up the lines, especially in the north, where there was danger from Austrian influence, and by about 1875 a considerable part of the mileage of the kingdom was owned and operated by the state. So that by that time Italy seemed committed to what may be called the Belgian system of state ownership and operation. But Belgium was rich and Italy was poor, and it was soon found that the state was neither managing the lines well nor making any money out of it; there was, therefore, general dissatisfaction throughout the country with the railway system; neither the poorly served public nor the depleted treasury of King Victor Emmanuel was satisfied. It was in that state of affairs that the investigation of 1878 was undertaken, the result of which was that the Italian statesmen who had the matter in hand came to the conclusion that it was not the proper function of the Italian state to run its railways; that state management in Italy had proved more costly and less satisfactory than private management, and that the carrying on of so vast an undertaking by the new state involved political risks and dangers of a serious nature. The outcome was the chartering in 1885 of three private companies, one, the Adriatic, for the territory on the east of the Apennines, a second, the Mediterranean, for the territory on the west, and a third, the Sicilian, for Sicily, the two systems in the peninsula being of about equal consequence, while the one in Sicily was, of course, smaller. A fourth company has since been chartered to operate the lines in Sardinia. These companies were to take over the rolling stock of the lines within their respective territories at a valuation, and thus become the owners of it, and to maintain and operate the lines, dividing the gross receipts with the state on an agreed basis. So that the ultimate solution was that the state was to own the lines, while private companies were to operate them. Practically the railway business of Italy proper is in the hands of two companies, one on either side of the Apennines, the lines meeting at Naples, Rome, Florence, Milan, and elsewhere. Between 1881 and 1897 the length of the Italian railway system almost doubled itself, and in 1898, there were 9,818 miles of line open for traffic. The service is satisfactory and the railway system is making rapid progress throughout the kingdom. Thus we see that in Italy, competition preceded combination; that it was found to work mischief and that attempts at combination were the inevitable result; that when the matter was taken seriously and intelligently in hand by the state, competition was eliminated by law, and the territory divided; and that then, and then only, were satisfactory results secured in railway operation. It appears, therefore, that whether we choose state operation as in Belgium or reject it as in Italy, it is the same as far as competition and combination are concerned; that the same economic laws govern in each case, and that in the long run competition is eliminated.

Germany.— Railways in Germany grew up very much as they did in England, at first without any general plan, and without any real comprehension or appreciation of the problems involved. The Germans, however, like the English, seem to have started right on the question of competition. Their earliest statutes explicitly recognized the right to a monopoly in their first lines. The country then consisted, aside from the central kingdom of Prussia, in large part of a number of semi-feudal principalities, and local railway systems sprang up in each of the states, which now constitute the present German Empire, so-called. Prussia followed Belgium in a general way in her early legislation and initial construction. The first state railway in Germany was built in Prussia about 1848–50, from Berlin toward the Russian frontier. Other state lines followed, but, *pari passu*, many private lines were laid down, some of them securing some state aid, by way of guarantees or subsidies or stock subscriptions from the principal states. Some, however, even of the smallest principalities, at first owned their lines outright and operated them too. So there was at the start every sort of a railway in Germany. This haphazard and piecemeal work begot the inevitable result — fierce competition everywhere among the private companies and between them and the state roads. The results were extremely dissatisfactory; the service was poor and the rates high. About 1861, Bismarck came into power, and from that time dates the influence of militarism upon the railway system of Germany. It has since shaped and colored the whole development and operation of the German lines. He saw clearly enough that the mixed and competitive system was a bad one, not only from a military point of view, but also from the point of view of the country at large. Steps were, therefore, gradually taken, in Prussia especially, to acquire the private lines and to consolidate competing and conflicting interests. The matter moved slowly because the country was poor, but the mileage nearly doubled between 1865 and 1875. After the war with France in 1871, more rapid progress was made in unifying the railway system of the country. By 1878, there were about 3,000 miles of state-owned and operated lines, 2,000 miles of privately-owned and state-operated lines, and about 6,000 miles of privately-owned and privately-operated lines. In 1881, the government owned more than 7,000 miles of line, only about 3,000 miles remaining in the hands of private companies. In 1885, the government owned 13,000 miles of line in Prussia alone, while only 1,000 miles remained in private hands. In 1900, there were 30,597 miles of railway in the German Empire, more than 93 per cent of which were owned and operated by the state. Under the present law the government is required to manage the railways "in the interest of general traffic as a single system," and in 1886 the government issued a Code of Railway Regulation, applicable to the whole railway system of the country. Competition practically ceased in Germany by about 1875, and for the past quarter of a century the railways of the country have been operated on noncompetitive lines. Pooling arrangements with the canals and other competing waterways are sanctioned, in order fully to eliminate wasteful competition and unjust discrimination.

Austria.— In 1901, Austria-Hungary had 39,014 kilometres of line open for traffic. The first Austrian charter was granted in 1836, and construction went on actively thereafter until the revolution of 1848. The original idea was to follow the French system, and have the lines built and operated by private companies. Their statute of 1838, it may be noted, was the first general railway law enacted in any country in the world. It provided for undertakings by private companies, and for guarantees by the state of interest upon the cost of construction; it limited dividends on shares to 15 per cent, and absolutely prohibited the construction of parallel lines. It was discovered, however, as time ran on, that the French system was not well suited to the condition of things in Austria; and in spite of statutory prohibition, as the lines were constructed and put into operation, competition ran riot. There was also the usual iniquity growing out of constructing lines for a chance to speculate in the securities; and the competition of the waterways — of the Danube and the canals — although pooling between them and the railways was allowed and encouraged, added to the confusion and disorder of private management. So in 1873, Austria fell into line with the other countries of Europe, and started off in the direction of state ownership and control. In 1885, about three quarters of the mileage in Austria was, however, still in the hands of private companies; but all the lines in Hungary were at that time owned and operated by the state. By 1898, more than half of the Austrian lines were under state management, and the tendency sets more and more in that direction.

Russia.— In May 1900, Russia (including Russia-in-Asia) had 41,400 miles of completed railway, and 8,000 miles under construction, including the great Trans-Siberian line, which is the greatest railway enterprise yet undertaken anywhere. Work began on this line in March 1891, and it is now open for traffic. The estimated cost is about $500,000,000. The distance all rail from Paris to Port Arthur or Vladivostok is about 7,000 miles, with a through-car service from *la Gare de l'Est* to Port Arthur and Peking. The government furnished a large part of the capital required for construction, and owns and operates about two thirds of the total mileage in European Russia; it has in addition subsidized and thus controls and dominates the policy of the lines owned and operated by private companies. The tendency, as elsewhere in Europe, is toward complete government ownership and operation. There is, therefore, in Russia, it will probably go without saying, no such thing as hurtful competition, and, consequently, none of the evils incident thereto.

The Minor Countries of Europe.—Elsewhere in Europe we find the same variety in railway operation and control as in other things; but the tendency everywhere is to government ownership or to such a strict government regulation as effectually eliminates anything like competition between the lines. Thus in Norway, in 1902, there were reported 1,203 miles of line, all now owned and operated by the government; whereas in Sweden, at the end of 1901, there were 7,217 miles of line in operation, of which only 2,392 were government lines. But although in 1893 there were reported to be not less than 108 different owners of private lines in Sweden, the law strictly and successfully prohibits competition between them, or between them and the state lines. The last available figures for the Spanish lines show 8,607 miles open for traffic in that country, all, as in Portugal, owned by private companies, but supported and controlled by the state. In Switzerland, where in 1899 there were 2,396 miles of line in working order, the governmental supervision has until recently been much the same as in Spain. In 1898, by popular vote, it was determined (in view of the evils of over-construction and some hurtful competition in spite of legislative prohibition) to purchase for the government the five chief lines, thus putting Switzerland in the Belgium class of countries owning and operating their railway lines. This scheme is now being financed and carried out by the Swiss government. The railway history of these relatively unimportant European countries is of much less interest and value to us than that of the greater states. The Italian system has been followed substantially in Holland, and in Denmark, and by some of the other minor Scandinavian countries.

India.—The construction of railways in India, which commenced in 1853, has been conducted on three different systems: first, the employment of companies under a system of guarantee; secondly, by the state through its own officials; and thirdly, by assisted companies either with or without guarantee or subsidy from the state, and working with capital wholly raised by themselves or partly with capital provided by the state. Out of eight lines constructed on the first system, five have been purchased by the state. Two of these are worked by companies. The more important, the East Indian line, is carried on by the same company that constructed it in the first instance, on special terms as to the sharing of profits. The second, the South India line, is in the hands of a new company, whose capital was subscribed by the shareholders of the old one. The three remaining lines are worked by the state, and all five come into the category of state lines in the accounts of the government of India. The total number of miles of Indian railway open for traffic on 31 March 1902, was 25,529. Although construction began about the middle of the last century, the system has been developed almost entirely since what English writers on railway problems speak of as "the rise and fall in England of the great fever known as the railway mania," to which detailed reference has hereinbefore been made. The Indian railways were, therefore, planned and constructed in the light of the experience afforded by the home construction and development, and many of the cruder home blunders were thus avoided. They now fall into one or other of four classes: (a) State-owned lines, worked by companies; (b) state-owned and state-operated lines; (c) lines constructed by guaranteed companies, and (d) lines constructed by assisted companies. The English government, following the French led in that respect, provided for a system of guarantees, by which the necessary funds were cheaply found; in laying down the lines paralleling was avoided, and competition effectively prevented. Where there is no competition there is the less incentive for combination, and there seems not to have been any great tendency in the Indian lines to combine. India, therefore, stands negatively for the soundness of my position. These railways seem to be rather poor affairs; there is much complaint of indifferent service and high rates. How far these things may be chargeable to the inefficiency of the government or may be due to the system itself does not appear. They have up to the end of 1899 involved a yearly loss to the Indian revenues, but the working of the year 1900 resulted for the first time in the history of the Indian Railway system in a net gain to the state of Rs. 87,239, and in 1901 Rs. 1,154,119. From the commencement of railways in India, about half a century ago, to the end of the year 1899, the loss to the Indian revenues amounted to Rs. 57,811,487. Whatever else may be true of the Indian lines, they have been constructed and are operated entirely on the principle of non-competition and division of territory, and there being no competition there has been little tendency to combine; in other words, the evil of competition not existing or not being allowed to exist, there is no call for combination. This is, as I have said, negative evidence in support of the contention that wherever competition is possible combination is inevitable.

Mexico.—The present railway situation in Mexico is fully disclosed in an exceedingly valuable report recently made to the government by Senor Limantour, Secretary of Finance. It purports to have been based upon a careful investigation of the facts, and is on the face of it as intelligent and comprehensive a state paper as any that has emanated in recent years from any government office anywhere in the world upon the subject. The fact that Senor Limantour, who is now virtually prime minister of Mexico, has been nominated by President Diaz as his successor in the presidential office suggests his high standing at home and gives weight abroad to his views on these questions. This report, which seems largely to speak the voice of the secretary himself, deals at length with the problems of competition and combination, and discloses the fact that the policy of the Diaz administration, as now settled and determined, is to meet and solve these problems by absolute government ownership, rather than by any further futile attempts at legislative control. The government, finding that the general railway law of 1898 (from which, when it was passed — as in the case of our original interstate commerce law — great things seem to have been expected) was proving inadequate to the due regulation and administration of the lines, and realizing the necessity of stronger and surer governmental control, has lately come to the policy of going into the open market and of adopting the same tactics as private individuals or companies in purchasing the shares of such lines as it desires to control. Mexico is, therefore, now fully committed to the theory of governmental ownership, if not to that of governmental operation. The government is just now offering to purchase the Vera Cruz & Pacific line, which has just been completed by American capital and lost to its original owners by the recent suspension of the Maryland Trust Company of Baltimore. Those portions of Senor Limantour's report which disclose the processes by which the government has acquired and is acquiring such a proportion of the shares of the leading lines as will give it due preponderance in their control are very interesting. The explanations of the causes which have moved the government to this step, as contained in the report, are of an even wider interest and significance to students of the railway problem. In brief, Senor Limantour's explanation is this: The government has until recently been in the usual elementary attitude of encouraging by concessions, subsidies and otherwise all the railways which either citizens or foreigners would undertake to build and operate as private enterprises, in the supposed interest of the most rapid possible development of the country. It was only in 1898 that a general railway law was passed, which, however, soon proved entirely inadequate. It was, therefore, in addition found necessary to prescribe new rules relative to granting concessions for competing lines between points already connected, and to establish a tariff commission — something like our Interstate Commerce Commission — which was an attempt, through the agency of a governmental bureau, to prevent combinations in freight rates, and to regulate them in the public interest. In the light of the experience of other countries — and, as it appears, especially in the light of the experience in the United States — competition between the lines is by this report pronounced harmful, "except where traffic is large enough to support it" — whatever that means. Government ownership and regulation is declared to be the only real preventive or remedy against such disastrous competition — with its inevitable result of the consolidation of competing interests. It is further suggested that the fact that groups of foreign capitalists had undertaken to consolidate several of the principal lines, obliged the government to take a definite attitude lest their great railway properties should thus be taken over and controlled by alien capital. It was clearly seen that these contests for territory between the hitherto conflicting interests would eventually and inevitably result in either the forced or the voluntary consolidation of the competing systems. The law as it stood was inadequate to prevent the acquisition in the open market by any private interest of a control of the shares of any company sought to be acquired, and there was no way to prevent the consolidation of interests through voting trusts or otherwise. Specifically, the situation in the early part of 1902, which seemed to drive the government strongly in the direction of state ownership and control, was this: The railways of the country were found already to be in the hands of no more than four groups of capitalists, namely, the Central, the National (having lately absorbed the International), the Interoceanic and the Mexican — all but the last showing great expansive activity. The Central especially, by the recent purchase of exclusive port concessions and the building of new lines in and out of the City of Mexico, was threatening to cripple the National line. Plainly, therefore, consolidation between it and the Central would inevitably follow in the ordinary course. Meanwhile, through Messrs. Speyer & Co., the National was trying to acquire the control of the Interoceanic route, but this was frustrated by the government. Various circumstances favored the government as against the foreign bankers in its secret move to secure control of the Interoceanic's debentures. "The ability and high financial standing," says the report, "of the firm representing the interests of the Mexican National constituted a serious obstacle to the attainment of our aims, and it was necessary to act as we did with decision, rapidity and absolute secrecy." A proposition for a common exploitation by the government in association with the National, the International and the Interoceanic companies followed; "but it was soon recognized that such an arrangement could not have the necessary durability nor afford the indispensable conditions whereby the companies might secure themselves definitely against the hostility of other corporations to which they might be exposed in time." The government thereupon, wisely declining to be drawn into any partnership arrangement with the companies, reverted to its original plan, namely, an arrangement such as would give the state primary and absolute control of the three systems, and in such a way as to protect each of them against such future competition as would be sure to arise under the existing state of things. The report declares that the government has now determined to grant no concessions hereafter for competing parallel lines, except in territories where dividends can be earned by each such line. Several voting trusts, in some of which the government has had an interest, have existed in Mexico, but some of these have lately been dissolved upon the advice of American counsel.

It was at first proposed that the government should exercise control of the new consolidated system through the voting trust of the National, already in existence. But, "according to the valued opinion of American attorneys, who are specialists in affairs of this nature, it would have been attended with many objections of a legal character, and have proved a fruitful source of litigation." Accordingly, the consent of its three members was obtained, and the voting trust dissolved, an agreement being entered into with Messrs. Speyer & Co. whereby they were to secure for the government 40 per cent or more of the voting shares. The report then enters into a detailed account of the steps by which this was successfully accomplished, 47¼ per cent of the shares being thus secured. It also goes fully into the question of the probable earnings of the consolidated railways and of the issuance of treasury notes for $12,500,000, American gold, to pay for them. The advantages to the government, growing out of the control of the new consolidated system, is summarized in the report as follows:

> 1. The having obtained by one stroke the control of the lines belonging to the National and International without losing control of the Interoceanic.
>
> 2. Having secured a considerable reduction in the total cost of the operation; and
>
> 3. The ability to effect payments in such manner as in no wise to disturb the equilibrium of the budget, and out of funds which in the long run will be recovered by the state.

Repeated reference is made throughout the report to the railway situation in the United States, and it is obvious that our experience has strongly influenced the Mexican government in its new departure in the direction of state ownership. They have learned our lesson before we have learned it ourselves; and now that Mexico has come into line with the rest of the world in its attitude upon the question of railway competition and combination, the United States stands alone among the greater commercial countries of the earth in continued persistence in the futile attempt to secure competition between railway lines and to prevent combination and the consequent division of territory; and it leaves us upon the general questions involved and upon the larger issues of the railway problem, quite alone. From a return prepared by the French Ministry of Public Works, it appears that there were in Mexico in 1870 no more than 349 kilometres of line; that in 1880 there were only 1,120 kilometres, while in 1890 there were 9,713 kilometres, and in 1900 a total of 15,454 kilometres of railway in operation — now, as we have seen, all substantially under government control or presently to pass thereunder, as the result of the investigation and comparison of the advantages of private versus government ownership and operation set forth in Senor Limantour's report.

Australia, etc.—In Australia, state ownership and control has since about 1860 been absolute and universal. The latest available statistics show 12,926.75 miles of line open, namely: In New South Wales (30 June 1902), 3,025.75 miles; in Victoria (30 June 1901), 3,221 miles; in South Australia (30 June 1901), 1,736 miles; in Queensland (30 June 1900), 2,801 miles; and in West Australia, 2,143 miles, by the last report. While there was at first some construction by private companies, every mile is now state railway. In New Zealand, in March 1902 there were reported 2,235 miles of state railway, and 88 miles of private lines. The figures intimate that there is no serious competition there.

South America and Africa.—In South America the governments generally own the lines. In Brazil, in 1897, there were 9,072 miles of line open and 3,500 miles in course of construction. Of this mileage the state actually owns but a small part, but it subsidizes the rest, and thus exercises an efficient control over all, which effectually prevents duplication and competition. In the Argentine there were reported in 1901 about 10,259 miles of road, mostly government lines. Chile in 1902 reported about 3,000 miles open, of which 1,458 belong to the state. The French possessions and dependencies in North Africa reported, in 1900, a railway system amounting to 4,628 kilometres in length, as against 3,595 in 1890, and 517 in 1870; British South Africa seems to have had, in 1900, nearly 6,000 kilometres of lines in operation. There were about 2,000 kilometres of line open in the Transvaal at the commencement of the Boer war, and about 400 kilometres in the Kongo in 1900. The total length of all operated lines in Africa, including the foregoing, the Egyptian lines (2,063 miles), and some little development in Portuguese East Africa, amounted in 1900 to 18,467 kilos, substantially all of which is government line. Competition and combination are, therefore, not open questions in Africa. The several European countries that have built the lines there either operate them directly or see to their operation on a strictly non-competitive basis.

Conclusion.—From the foregoing general view of railway history and development throughout the world, it appears that there is a universal and irresistible tendency in competitive railways in the same territory to combine and to divide the territory between them; that attempts by legislation or litigation to prevent it have uniformly failed; that states which at first recognized and sought to enforce the principle of competition between railways have one after another ultimately abandoned the attempt; that nowhere, except in the United States, is the principle of competition now recognized or still sought to be enforced; that railways in new countries or colonies of old countries, constructed during the last quarter of a century in the light of the experience of the older countries as to competition, have been constructed and operated from the start on non-competitive lines; that the amalgamation of parallel and competing lines is entirely consistent with good service, reasonable rates, and adequate governmental supervision and control; that where railways compete there is always an enormous waste of capital and effort and frequently poor service and high rates; that the tendency everywhere is to eliminate competition where any measure of it still exists; that government ownership is good or bad according to the point of view; that there is a strong tendency in Europe, and elsewhere except here and in England, toward government ownership and operation; that the governments of Europe, with 10 times the police power of our own, have long since abandoned all attempts to hinder and thwart the laws of trade and commerce by restrictive legislation, or to prevent the inevitable in railway development; that, instead of opposing this economic evolution, the most enlightened European governments have on the contrary legalized it, and seek to enforce and regulate it in the public interest; that the best and cheapest service is secured where competition is impossible, and where the state puts the emphasis of its effort, not on interference with railway finance, but on securing good service at fair rates.

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Railway Construction. *Tracks.*— The railway track more than any other part of the railway machine had a crude beginning, and has reached its present condition of excellence by a continuous series of improvements. In the first series of railroad construction, tracks of numerous designs were built, the chief thought of the builders being to secure a solid structure that would not allow the rails to spread. The track was of necessity relatively heavy and expensive in relation to the weight of the rolling-stock and volume of traffic. Three kinds of rails were used, the one most generally employed consisting of strong wooden beams surfaced with strap iron. The iron rails first used were cast and their length did not exceed 3½ feet. Rolled rails were soon substituted for those of cast-iron and the length was increased to 15 feet, with a weight of about 40 pounds to the yard. As late as 1844 all rolled-iron rails used in the United States were imported from England, and were in the shape of an inverted V. The T-rail now universally employed was not much used during the first 20 years of railroad construction. Since 1870 rolled steel has been used instead of iron, and the weight of the rail has been steadily increased to 110 pounds to the yard. One hundred pounds to the yard has become the standard upon tracks where traffic is heaviest. The standard length of rail has been maintained at 30 feet, but at the present time some track is being laid with rails 60 feet in length. Along with the improvements in the track, bridges and other structures have been strengthened to meet the necessities of modern transportation methods.

Construction.— A perfect and safe track should be complete in all respects; full bolted, full spiked, well ballasted, surfaced, lined, and gauged. The best dirt ballasted track is made, when laying it, by bedding the ties to a level surface on top before putting on the rails. If it is intended to ballast track with cinders, gravel, or stone, as fast as it is laid, the tie bedding should be omitted in order to have the full width of the grade upon which to deposit the ballast, but at the same time the ballasting should be kept well finished up to obviate the danger of spoiling the rails. When laying the rails care should be taken to give the proper space at the joints for expansion. Too much space at the joints must be avoided in order to prevent the car wheels from battering the ends of the rails. The coefficient of expansion for steel is .0000065 of the length for each degree. For a rail 30 feet long and a difference of 100 degrees, or from 10 degrees below zero to 90 degrees, the amount to allow would be one-quarter inch. To take up the flow of the rail one-eighth inch must be added, making a total allowance of three-eighths inch. A steel rail expands or contracts $\frac{1}{100,000}$ of a length under a load of one ton (2,240 pounds) per square inch. This is also its expansion under a rise of 15 degrees of temperature; consequently, if a 30-foot rail is subjected to a rise or fall of 15 degrees, it exerts a force of one ton per square inch if resisted. Where angle bar splices are used on joints, the best method to hold steel and to keep it from creeping down grades or from running ahead enough to throw the track out of line or kink the rails is to use the slot spikes in the splices. Short rails (less than 10 feet in length) should never be used in making connections except in cases where it is absolutely necessary to use short pieces of rail, as at the end of frogs, in the roundhouse tracks, etc.

Spiking and Gauging.— All tracks should always be kept full spiked and in perfect gauge. Bad gauging detracts from the appearance of an otherwise good track, makes track easier to knock out of line and down below the surface, and is the direct cause of wrecks. The spikes should be driven about 2½ inches from the edge of a track tie. Both inside spikes should be driven on one edge of a tie, and both outside spikes on the other edge in order to prevent the tie slewing and also to assist in holding the rail from creeping.

Drainage.— In order to ditch a cut properly, it is necessary to take measurements from the rail to the bottom of the face of the cut, at different points along the cut, and ascertain at what average distance from the track the back of the ditch should be located. The width of a cut and the slope of its face on each side of the track will govern, to a certain extent, how far from the track rails to place the back of the ditch. The ditch should be deep enough to thoroughly drain the track, and the distance from the rail to the back of it should be in proportion to the depth of the ditch, giving the water an easy fall from the track and full passage through the ditch, avoiding all danger of its washing the shoulder of the grade or undermining the track. As a general rule the bottom of the ditch should be 8 or 10 feet from the rails where the grade width will allow it, and about two feet below the bottom of the ties. When the track is ballasted with dirt, the slope should commence in the centre of the track 2½ inches above the ties, falling at the rate of 1½ inches to the foot. From this point, which is three feet outside the ties, and two inches lower, the incline should be greater, about in the proportion of four inches to the horizontal foot. If the track is ballasted with gravel, the slope toward the back of the ditch should commence about two feet outside the track rails, the ballast at this point being level with the base of the rails. To insure a thoroughly good drainage, all the water which falls upon the track or adjacent land, should be conducted through ditches, culverts, bridges, or other channels to the nearest running stream that will take it away beyond all possibility of injuring the track. Where musk rats or minks are plentiful and cause damage to the track by burrowing under it, a heavy coating of cinders and slag along the sides of the embankment is an effectual protection against their depredations. The cinders form an acid in the water and at the same time are too sharp for the animals to burrow through.

Vitrified Pipe Culverts.— The use of vitrified pipe for culverts under railroads has continued in constantly increasing volume since

1878, its advantages are now fully appreciated, and experience has pointed out such treatment as will insure the best results in efficiency and permanency. In northern latitudes especially, where severe cold prevails, the culvert should have a good fall, and be so constructed that no standing water be allowed to remain in the pipes and freeze. When drainage capacity greater than that afforded by one pipe is desired, two or more lines of pipe may be laid side by side. This practice is quite common, and gives an important advantage in that the full capacity of the pipes is utilized at a lower depth of water, but the separate lines for pipe should be laid far enough apart to secure a solid bed for each one. No arbitrary rules can be made for work of this character. Varying physical conditions must be met and each particular work treated separately on its merits. Under especially favorable conditions of good soil, light embankment, and good drainage, there is no doubt that the pipe culvert may be put in without cement and without end abutments, insuring complete construction at a minimum cost, but the durability of vitrified pipe being conceded, the permanency of the work is a prime consideration, and the wisest economy would seem in all cases to suggest the use of concrete as a foundation for the pipe, and that each end of the pipe culvert be protected by parapet walls of substantial stone or brick masonry.

Ballasting.— If stone is difficult to obtain, a good track can be made with gravel and stone combined for ballast. The foundation for the track should be laid with broken stone and above it should be placed a quantity of coarse gravel sufficient to bed the ties, surface the track, and dress it. Cinders are equally effective as a ballast, except in wet cuts, when stone should be used, and are cheaper than either stone or gravel. Six inches of cinders will absorb about one inch of rainfall and will thus keep the foundation beneath the ballast dry. They make a superior ballast on clay fills or gumbo bottoms, and are a positive exterminator of weeds. Where the sub-grade is well drained and solid, an excellent track can be made by ballasting with two cars of gravel in a place, and to accomplish the work in this way, estimates may be taken at the rate of 325 cars of gravel to the mile of track. The embankment should not be less than 14 feet wide on top before putting on the gravel. Although *locomotive cinders, furnace slag, burned clay,* and *gravel* make excellent ballasts, within the past few years the best results have been obtained from stone ballast where the stones are sufficiently small to pass through a 1½-inch ring. The first cost of stone ballast is large; but, once in place and thoroughly tamped, it is extremely solid, will arrest the springing action of the track, and will insure a nearly perfect drainage.

Laying Rails.— Owing to the difference in quality and in the amount of traffic over the rails, it is quite difficult to form a correct estimate of the average life of the same. Good iron rails have been known to last, in service on the main track of a railroad doing a fair business, 9 or 10 years, and steel rails, 15 to 20 years. There is much discussion on the subject of broken or even joints. The majority of track has heretofore been laid with even joints; but, at the present time, all rails are being laid with broken joints, which consists in placing the rail joint on one side of the track opposite to the centre of the rail on the other side of the track. Outside of the general line and surface, the principal defects in steel rails are pipes, gag marks, and cinders, which result in flaws. Owing to heavy engines and cars of great weight now employed, heavy rails are demanded to be used and as the height gives vertical strength, in such heavy rails used, height should be the main consideration, and should not be less than six inches. To give good wearing heads, the proportion of metal in the head should be kept down to the minimum, as owing to the present process of rolling steel rails at a great heat from a large ingot, a thick head will not give as good results as a thin head rail. The web should be thicker at the base than under the head, which in the high rail insures greater strength, as the tendency is to break at this point, if too weak.

Wave Motion.— As all the rail movements are on the principle of the lever, there is, of necessity, an undulatory motion on the passage of each train, the amount of which being dependent on the condition of the sub-grade, ballast, ties, rail, and weight of the rolling stock. The less substantial the superstructure, the greater ballast compression there will be, and, of necessity, a rough-riding track. The foundation of all ties being loosely compacted material, any movement or "churning" of the tie necessarily throws unequal loading on the ballast at different times, causes its compression and movement, and destruction of the tie foundation. The wider the ties and the lighter the rail and the heavier the loads, the greater such movement must be. Rails take a permanent set, as regards wave motion, in one of three forms: (a) Joint low and centre high. (b) Joint and centre low, quarter high. (c) Entire rail wavy. As the vibratory motion of the rail takes place, something has to give way. If the fastening to the tie is by push bolt or lag screw, the tie will be raised with the vibration and "pump" the ballast, and in time the fastenings will become loose.

Elevation of Curves.— The elevation of curves has been a subject of much discussion. Twenty years ago, one-half inch elevation per degree of curve was considered proper; but now, with faster and heavier trains, a greater elevation is required. Engineers claim that one inch per degree for a speed of 60 miles per hour is proper for curves of three degrees or less, but for each additional degree the elevation should not exceed ¾ inch. While practice teaches the amount of elevation needed in any given case, it is a safer plan to follow the ensuing formula deduced from mechanics in following the theory of elevation; $E = \frac{v^2 g}{32.16R}$, in which E represents the elevation in feet, v^2 the square of the velocity in feet per second, g the gauge or the distance between the points supporting the wheel, or from the centre of one rail head to the centre of the other, and R the radius of the curve in feet. This rule, though scientifically correct, cannot always be applied in actual practice, because all trains do not travel at the same rate of speed. Practical provision must be made for the average speed of trains and the number in each class of service. For example, if a road have two trains whose speed is 50 miles per hour, four with a speed of 40, and six or eight with a speed of 25 miles per hour, one inch per degree of curve will be found suitable. The pressure by the fast train against the outer rail of a curve will not be sufficient to spread the rail or throw the track out of line. The elevation will be about right for the 40-mile trains, and while it may be excessive for the slow trains, yet they will do no particular damage to the track and will have a tendency to prevent the track being moved permanently outward by the fast trains. The liability of derailment of locomotives or cars is much greater on a curve track than on a straight track, and a large percentage of such accidents is chargeable to the defects in the rolling stock as well as to the defects in the track itself. Heavily loaded cars often leave the track owing to the failure of a truck to adjust itself to the curve of the track, caused, perhaps, by a defective curve roller, and the greater part of the load resting upon one side of the truck.

Frogs and Switches.— The turnout, by which a car may pass from one track to another, consists of a frog, a rail leading to the frog, a corresponding opposite rail, and a device connecting these rails with the main track known as the *Switch*. If the switch is made to serve two turnouts, it is called a *three-throw switch*; a *trailing* switch is one where a train on the main track passes from frog to switch, while a *facing* switch is one that approaches in the opposite direction. The common or *stub* switch consists of a pair of connected rails so arranged that while one end is fixed, the other can be moved so as to be a part of either the main track or turnout. This switch has two serious defects — the want of safety and the necessary space at the end of the moving rail, which jars the rolling stock, batters the switch rails, and causes discomfort to passengers. The first cost of a point switch is more than a stub, but the split which is more economical to maintain, and safer, is cheaper in the end. In laying switches the general rule is to cut the least number of rails. When putting frogs into a track care should be taken to have them in a true line and level with the track rails which are connected to them. The gauge rail, opposite the frog, should be put to a perfect gauge for the full length of the frog.

The *spring rail* frog has been designed with a view to safety. All four ends are spliced solidly together as in a rigid frog. The hinge rail is attached to the main rail by a bolt hinge. This allows the rail to move freely and prevents it from creeping endwise. It is attached to the movable part of the running rail by strong bolts passing through both rails and a wrought iron filling.

Safety Appliances.— The greatest care must be exercised in the instalment of safety devices, as far as practicable automatic, without discouraging watchfulness on the part of engineers and others. The plan of sealing the stopping mechanism and imposing a severe penalty for breaking the seal is an excellent one. The most carefully planned automatic devices should be provided, and no railroad train, traveling at terrific speed, and representing enormous energy, should be allowed to run without any safeguard between itself and disaster beyond the watchfulness of one man, who may be taken ill, or suffer from a temporary mental aberration, or may even die suddenly and unnoticed.

Transfer and Turntables.— These important adjuncts should be constructed so as to be conveniently driven by motors with an electric motor; no expense is incurred when the table is idle, and the cost per transfer or turn is much lower than when either steam or hand power is used. Many railroads are putting in electric turntables, and careful investigation shows that the cost per turn by electricity is from 30 to 50 mills, while with hand power it is from 10 to 15 cents.

REQUIREMENTS FOR ONE MILE OF TRACK

No. ties per 30′ rail	No. ties per mile	No. tie plates per mile	4 spikes to tie		6 spikes to tie		Length of rail	No. rails per mile	No. splices per mile	No. bolts per mile		Fence posts	
			No. spikes	No. kegs.	No. spikes	No. kegs				4 hole splice Bolts	6 hole splice Bolts	Ft. apart	No. one side
15	2,640	5,280	10,560	28	15,840	42	20′	528	1,056	2,112	3,168	8′	660
16	2,816	5,632	11,264	30	16,896	45	22′	480	960	1,920	2,880	12′	440
17	2,992	5,994	11,968	32	17,952	48	24′	440	880	1,760	2,640	14′	377
18	3,168	6,336	12,672	34	19,008	51	26′	407	814	1,628	2,442	16′	330
19	3,344	6,688	13,376	36	20,064	54	28′	378	756	1,512	2,268	16½′	320
20	3,520	7,040	14,080	38	21,120	57	30′	352	704	1,408	2,112	18′	293
							33′	320	640	1,280	1,920		
							60′	176	352	704	1,056		

Drawbridges and Liftbridges.—Electricity has a specially valuable field in connection with the operation of drawbridges and liftbridges. Speed and control are the requisites of modern methods, and the old plan of operating a drawbridge by a capstan worked by several men is now practically obsolete. A few years ago, the drawbridge at Hamilton avenue over the Gowanus Canal in Brooklyn, N. Y., was operated by from three to five men working on a capstan. Then it took four or five minutes to complete the operation. The electric motor which has been substituted opens and closes the bridge in 50 seconds, and the services of but one man are needed. When electric current can be obtained, practically all drawbridges now designed are constructed to operate by electric motors.

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Railway Construction, Street. See Street Railway Construction.

Railway Economics. In one sense railway economy is only a branch of the general subject of political economy (q.v.). The laws which govern railway rates, railway profits, or railway control are fundamentally the same as those which govern the rates, profits, or control of any other kind of industrial enterprise. But among all our important industries the railway is the one which has most quickly and completely felt the effect of modern methods in the handling of capital. For this reason it is useful to make railway economy a subject of special study, because it indicates the possibilities and difficulties which lie before our statesmen in the future, as distinct from those which they have habitually met in the past.

The feature which distinguishes modern industries from those of earlier times is the large investment of fixed capital. Two or three centuries ago we had unimproved farms, small stores and shops, rude boats and wagons. To-day we have highly developed systems of cultivation, large stores and factories, and complex means of carriage by land and water. But nowhere has the change been so marked as in the character of the highways on which commerce is handled. The rough road of ancient days has given place to the turnpike, the turnpike to the canal, the canal to the railway; and with each successive generation the railway itself has become an instrument of increased size and strength.

The effect of all this change has been greatly to reduce the cost of transportation. But this result has not been reached in any simple manner. One set of elements in the cost — the so-called *fixed* charges on capital — has been enormously increased. The country road of our great-grandfathers may have cost from $300 to $500 a mile. The turnpike road cost ten times as much — perhaps from $3,000 to $5,000. The old-fashioned railway, conforming itself closely to the original character of the ground, with steep grades and sharp curves, could be built for $30,000 a mile. The modern trunk line, where grades are reduced to a minimum and every engineering appliance is most highly developed, costs $100,000, $200,000, or in some parts even $300,000 a mile. And yet it is the expensive appliance which does the work cheaply.

The general explanation of this paradox is simple enough. The higher the fixed charges per mile of road, the lower is the expense of carriage for each ton of traffic. The old-fashioned road cost perhaps $25 per mile per year for interest and maintenance; but the expense of hauling a ton over a mile of such a road will run at least as high as ten cents. The turnpike costs perhaps $300 a year for interest and maintenance, but the expense of hauling a ton over a mile of turnpike will be less than a third of what it was over the old-fashioned road; because horses on a good road can draw three times as heavy loads as they can on a bad one, with less wear and tear to the wagons and to themselves. The interest and maintenance charges for a poorly located railway may be $2,500 per year, more or less. The direct cost of hauling each ton over a mile of such road will be in the neighborhood of one cent. Increase the excellence of the location and construction of your railway, and the annual interest and maintenance charges will increase to $5,000, $10,000, or even $20,000 a mile; but the possible train loads will increase so rapidly as the grades and appliances become better that the cost of hauling each ton will be reduced to half a cent, a quarter of a cent, or in some instances an eighth of a cent a mile.

The question which of these methods is the most economical depends upon the amount of traffic which you have to handle. If there are only a thousand tons of traffic in a year, it will not pay even to build a turnpike. For the saving of $70 which results from the ability to haul those 1,000 tons at three cents instead of ten cents will not pay the $300 a year interest and maintenance on a mile of turnpike. But if we are to carry 10,000 tons instead of 1,000 there is a saving of $700 instead of $70, and this makes the better road the more economical. If we can get $100,000 it becomes profitable to have a railway; and if we can get 1,000,000 it will pay to have that railway constructed with a very high degree of excellence. The more traffic there is, the more does economy in the direct cost of hauling count as a justification for an increase of fixed charges.

In a newly settled or slightly civilized community the possible traffic per mile is small, and the appliances must be correspondingly rude. Economy of fixed charges is of more consequence than economy of operation. But as time goes on these conditions are reversed. Increase of population means increased demand for traveling accommodation. Improvement in the arts means increased production, increased amount of freight to be carried to market and, what is perhaps of still more consequence, increased demand for the hauling of coal and raw materials and of food supplies for the laborers. Under all these circumstances there has been a demand for every invention which would enable a railway by an increase of original cost to do its work more economically. We have substituted steel rails for iron because they enabled us to carry heavier loads. We have for the same reason gradually increased the weight of our cars and our engines. The modern locomotive weighs more than the old-fashioned locomotive and burns a little more coal; but it hauls five and ten times heavier loads of freight.

Occasionally it will happen that railways are built or improvements introduced in advance of the needs of the country, where population is not sufficiently dense or productivity sufficiently high to support them. This was notably the case in the years preceding the crisis of 1857, and again in the years immediately subsequent to the Civil War. In both of these cases the traffic was insufficient to support the lines that had been built in the newer territories, and very serious loss necessarily resulted. But the general effect of railway development has been to create an enormous traffic at low rates, in place of the very much smaller traffic which was possible at the rates that prevailed before the railway was introduced or improved.

To this extent the effect of new methods of railway economy has been thoroughly good. But the good thus done has been accompanied by certain evils, which at times have proved very serious. The direct expense of doing each piece of business — of loading or hauling each ton of freight or carrying each individual passenger, which the railway agent must charge against every such piece of traffic — becomes very small in proportion to that contribution to the fixed charges of the road which there is no available rule for apportioning. These enormous fixed charges must be met somehow. But how much of them should be paid by passenger traffic or how much by freight traffic, how much by small quantities of valuable goods carried at high rates and how much by large quantities of cheap goods which will barely pay more than the direct expense, is a matter for the agents and managers to decide in their discretion. A railway rate really consists of two parts. It is a price for the loading or hauling, plus a tax for the general expenses of the road. The price element must be based on the cost of doing the work. The tax is usually based upon the ability of the goods to stand its imposition — or, in the current language of the market, upon what the traffic will bear. Manufactured articles will bear a rate per ton which would be simply prohibitory if applied to coal or ore. Therefore freight is classified; and instead of a uniform rate per ton we have several different sets of rates for goods of different classes. Short distance traffic will bear a rate per mile which would be prohibitory to long distance traffic. Therefore we make reductions in the rate per mile for long distances which would be ruinous if applied to short distances. Of course the element of economy of handling enters into these classifications and distance gradations; the low grade goods are on the whole cheaper to handle than the high grade goods, the long distance traffic is more economical than the short distance traffic; but the element of ability to pay the tax is the one which is of more consequence than all others put together.

But it is obvious that this taxing power is a very dangerous thing to place in the hands of private corporations, and one which is liable to be abused. To meet this danger and these abuses several remedies have been proposed.

1. *Competition between Different Carriers on the Same Line.*— This was the theory upon which the early railway legislation of England was based. It was supposed that a railway corporation would, like a turnpike or canal company, be primarily occupied with furnishing the highway; and that any carrier who should choose to build cars or locomotives could run his trains on the railway, precisely as he might run his wagons on a turnpike or his boats on a canal. It was impossible to apply this principle, partly on account of difficulties of operation — the danger of accident being very great if independent carriers tried to use the same line — but chiefly because a railway could handle its own cars and trains with advantages so much better than those which could be commanded by the cars and trains of independent carriers that the latter could not afford to pay the tolls fixed by charter.

2. *Competition between Different Lines.*— This was the theory which was at first favored in the United States. It was a little more workable than the English theory; but it can hardly be said to have produced better results. For if you have parallel railways, so that each producer has the choice of two lines, this duplication of plant involves a great waste and loss to the community; moreover, the competition between two such parallel lines often becomes so ruinous that it is followed by their consolidation. If, on the other hand, we have competition at some points and not at others, the places which get the benefit of the competition enjoy very much lower rates than those which prevail elsewhere, and we thus have discrimination, generally in favor of the large cities and often in the form of secret rebates in favor of the more unscrupulous shippers in those cities, which are an evil of very great magnitude. They tend to increase the drift, already too strong, from the country to the city; they also tend to substitute a system of underhanded dealings in business for an open and straightforward competition between producers on equal terms.

3. *State Regulation of Rates and Fares.*— This system takes two forms, according as this special liability to regulation does or does not carry with it the grant of monopoly privileges. In America, during our later period of railway legislation, we have tried to have such regulation without legalized monopoly. In France the two have been combined.

The danger in the American system of rate regulation, without the guarantee of special rights and privileges, is that the rates may be fixed so low that there is no profit in the business of railway carriage. Under such circumstances railway building will be stopped and the community will be deprived of the necessary development of its facilities. This was felt at the time of the Granger legislation in 1874. It was also felt, though to a somewhat less degree, in the years succeeding the passage of the Interstate Commerce Act. The community attempted to secure low rates without giving railway owners any corresponding consideration. The effect was that it got fewer roads than it wanted until the laws were changed or until population had growth to adapt itself to the new conditions.

A second danger in the American system is that a legislature which regards itself as the representative of the shippers' interests as against those of the railways will be always trying to stimulate spasmodic competition, as was done in the anti-pooling clause of the Interstate Commerce Act, and will tend to perpetuate those very discriminations or differences in charge which it is the main object of railway regulation to check. For it has been proved over and over again that if you have really active competition between agents of competing lines you do not secure that openness and equality of rates which is possible when such competition is abolished.

The French system of rate regulation is different from the American. By French law the whole country is divided into districts. Each railway has a monopoly in its own district, in return for which monopoly and for certain substantial subsidies given by the government the company is subject to certain well defined rights of control. The French system seems equitable in theory, but it cannot be said to have worked well in practice. For the agents of a railway company which holds a guaranteed monopoly have such an advantage in bargaining with the government that they find it possible to exact very large compensation for any concessions that they make to public demands. They get a great deal of profit in return for very little control.

4. *Direct Ownership and Operation by the Government.*— This is the system which has prevailed in Germany, especially during the last quarter of a century. Prior to that time Prussia and other continental countries had contented themselves with owning parts of their railway system, leaving other parts to be built and operated by private enterprise. The effect of this mixed system was that the state railways became virtually one private corporation among many. The companies dictated the policy of the government, instead of giving the government any opportunity to control the policy of the companies. To avoid this evil the Prussian government purchased substantially all of the railways of that country, and many other states have tried to follow the example of Prussia to the extent of their financial ability.

The excellence of a government railway system will, roughly speaking, depend upon the excellence of the government itself. If the administration is in financial straits the ownership of a railway system furnishes a temptation to tax the people which is too near at hand to be resisted. If, on the other hand, the government is in a sound position financially, it will adopt a much more liberal policy in the matter of charges. Such a government will probably try to meet popular demands more fully than some of our private corporations. But it is slower in perceiving commercial needs and wants, and hence will not respond as promptly to business necessities and to business opportunities.

There was a time when people discussed the merits of state and private ownership of railways as a question of theory, some being heated partisans of the one system and others equally hot partisans of the other. That time is now past. It is universally recognized among experts that a well managed state road and a well managed private road will adopt nearly the same policy. A large private railway system cannot permanently try to get very much more than a fair rate on its investment. A state railway system cannot, in justice to the taxpayers, afford to get very much less. For state roads have cost money which has been borrowed. The interest on the bonds must be paid, and these interest payments are usually quite as large as the dividends of countries which have private railways. Again, well managed state railways must adopt substantially the same principles of classification and distance gradation as private roads, because it has been proved that only by the adoption of these principles can the railways do the maximum service to the community at the lowest average rates. The chief difference between state railways and private railways is not in what they can do if they are well managed, but in the particular directions in which they are likely to err if badly managed. With private roads these errors will take the form of fraudulent issue of securities in connection with their capital and of favors to large concerns in their operation. With state roads they will take the form of wasteful and ill-judged expenditures for building and of lack of readiness to take advantage of new methods of operation. It is a somewhat interesting fact that if we take similar roads in different countries the inflation of the capital account due to water in stock of private corporations is just about balanced by the waste due to ineffectiveness of government contract work for public ones.

Though the abuses are different, the remedies are nearly the same in the two cases. Whether a road be operated by a private corporation or a public one, the first desideratum for good management is publicity in all its affairs— straightforward and simple accounting, open bidding with regard to contracts, adherence to the published rate sheets, promotion by merit and not by favor. If to this publicity of method is added responsibility to an independent judiciary, we attain a really salutary system of railway control, whatever the form of ownership or operation. It will be impossible for any railway managed under such a system to make its rates much higher than the rates of other parts of the same country, or even of other countries under similar conditions; because producers of different countries are competing in common markets. If Russian producers and American producers are competing in Liverpool, the charge from the Mississippi River to Liverpool influences the general schedule of transportation rates from the Volga to Liverpool, and *vice versa.* If we can secure fair treatment as between individual shippers, we can usually let the general schedule of rates take care of itself. We can let the agent adopt the system of charging what the traffic will bear if we insist that he does not make this an excuse for charging the individual what his traffic will not bear. For with a system of publicity of rates and responsibility of agents, it will be so obviously disadvantageous to the traffic of a railway itself to have an unreasonably high schedule of charges that enlightened self-interest will dictate the adoption of a tax system which will be more concerned to develop traffic, whether of freight or passengers, than to impose an unnecessary burden upon it.

Arthur T. Hadley,
President Yale University.

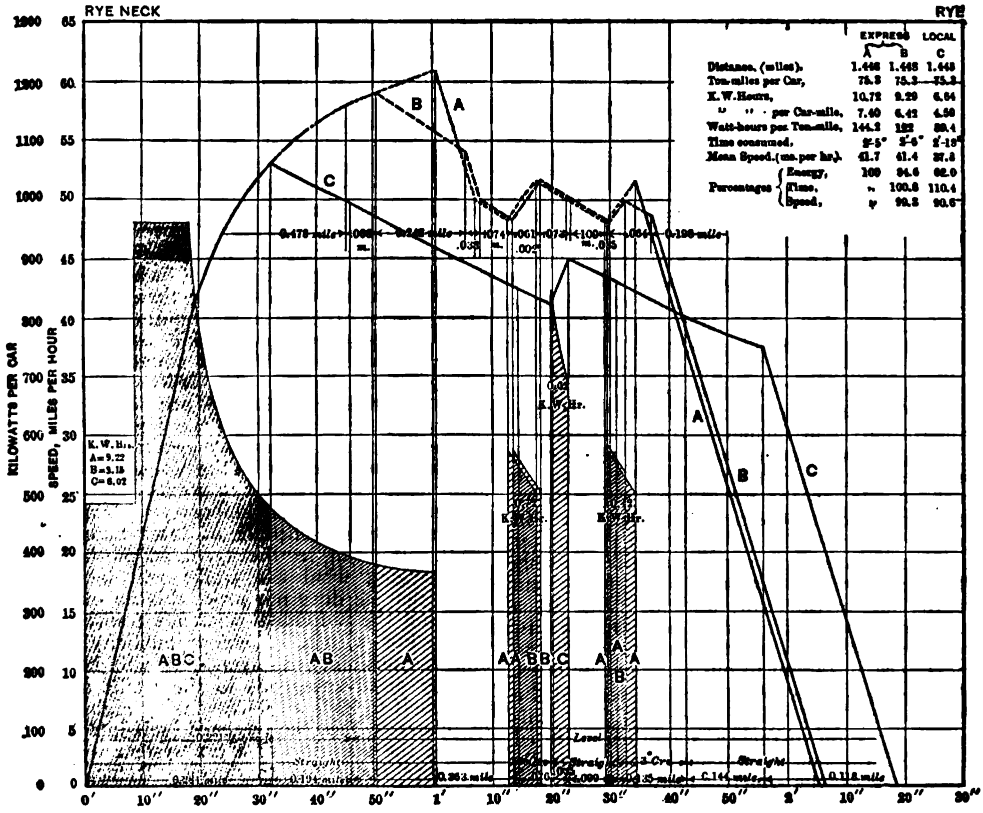
Railway (Electric) Economics. No single industry or art has probably ever, within an equal period of time, brought about as great changes in the activities of municipal life as has been the result of the development of the electric railway since 1890. Until about 1900 the development has been essentially that of street surface railways, operating on tracks laid in the street of centres of population, or upon public highways. On account of the use of the highways simultaneously by other forms of traffic, the schedule speed of railways where tracks occupy public highways is necessarily relatively slow (between 9 and 15 miles per hour). It is this speed limitation which has been the cause of the halt in the extension of electric railways, built upon public highways, into the suburbs. At first, too much was expected of these railways, with the result that population centres sprang up at points considerably distant from the cities. The incentives for this migration from the cities were the lower rents, lower cost of living, and, in general, better sanitary conditions of the outlying districts. Of recent years, there has been a very considerable return of the outlying populations to the cities, necessitated by the considerable and prohibitive time interval involved in passing between the suburban homes and the places of business, in the use of the existing suburban electric railways. Generally speaking, the suburban service of steam railroads has not supplied the existing want, on account of high fares, timetable limitations, and other aggravations.

The time has come when distance, especially in and about large population centres, is measured essentially and only by the time consumed. A man no longer lives 20 miles or 30 or 40 miles from his office, but he lives 30 minutes or 40 minutes, or one hour distant from his office. In other words, the time has come when the space interval, or distance, between two points or localities, such as two cities or towns, or the home and the office, has resolved itself entirely into a question of time consumed in passing from one point to the other, rather than any question of distance covered. Again, the constantly increasing costs of living in the large cities, due to well-known causes, is making imperative the population of the outlying districts, which can only occur with the advent and development of adequate methods of transportation.

Since 1900 the development of high-speed electric railways has been progressing with marvelous rapidity. The best of these newcomers adopt the highest class of steam railway practice in the construction of their permanent way. The essential characteristics of the coming interurban electric railways must be: (1) Safety to the public; (2) high schedule speed; (3) reliability of operation; (4) minimum cost of operation and maintenance.

None of the foregoing conditions can be satisfactorily attained where the cars are operated upon or along public highways upon which pedestrian and vehicular traffic also exists.

PLATE I.



	EXPRESS A	EXPRESS B	LOCAL C
Distance. (miles).	1.448	1.448	1.448
Ton-miles per Car,	75.3	75.3	75.3
K.W.Hours,	10.72	9.29	6.64
" " per Car-mile,	7.40	6.42	4.59
Watt-hours per Ton-mile,	144.2	123	88.4
Time consumed,	2'-5"	2'-6"	2'-18"
Mean Speed.(ms. per hr.).	41.7	41.4	37.8
Percentages Energy,	100	86.6	62.0
Percentages Time,	"	100.8	110.4
Percentages Speed,	"	99.3	90.6

Actual comparative run curves showing economic results of different schedule speeds. Compare tabular data at right of sheet.

Individual or private rights of way are the solution of the problem. The private right of way, however, should be an *individual* roadway throughout, that is, it should be free from grade crossings of all kinds, except at such special points and places where the cars run onto other tracks over which they are to operate.

Interurban roads, to be successful, must be capable of making high speeds, safely and continuously, and this cannot be accomplished where the roadway occupies the public highway or crosses intersecting highways at grade.

Furthermore, when a railway owns its right of way it is once and for all exempt from the demands, and continuously increasing impositions of public officials in the matter of annual payments to the local authorities as "compensation" for the use of the highways and of repairs to the space between its outside rails, and for various and constantly increasing distances beyond the outside rails. In such matters it has become the practice of some public officials to impose additional burdens every time a given railroad seeks any additional or other privileges in the matter of extensions, track facilities, etc.

In several existing cases interurban lines have been laid on public highways for considerable distances, when they could have purchased rights of way parallel to the highways upon which they have laid their rails, and but a few hundred feet from such highways, for merely nominal sums ranging between $1,200 to $2,000 a mile. For a road 30 miles in length, a private right of way costing as much as $3,000 per mile will increase the cost but $90,000 for the right of way and (allowing the maximum of three crossings per mile at an average cost of $5,000 each) about $150,000 for the crossings, or a total of $240,000. At 5 per cent the interest on this cost is but $12,000 per annum. As the items of operation and maintenance must be less for the road using a private right of way, they can safely be left out.

Consider the relative marked advantages which a private right of way 200 to 500 feet from the main road would secure. In the first place a schedule speed three or four times as great could safely be made, and as relatively high speeds and large daily car mileage per car are necessary to secure the best commercial results, for long haul business, this is all-important. In the second place the railway would be free from the petty annoyances, impositions, and demands of ignorant, unjust, or corrupt local authorities. In the third place its property must become more valuable each year as the adjoining territory builds up and settles, and within a comparatively short time it will probably have a railway through a thickly settled community, upon its own property or right of way, subject to no annoyances, impositions, or charges, except the universal and open real estate tax. In the fourth place it will be in a position to so manipulate and increase its schedules as to enable it to "get all there is out of the territory," and it can also arrange for and take care of any passenger or freight business of any existing or future connecting road or roads. In the case assumed in the preceding paragraph, the additional annual fixed charge for these advantages is $12,000, plus the annual real estate tax against which must be placed, for the care of a good road upon a public highway, the interest on the first cost of paving between the rails and for the required distance outside of the rails, plus the annual cost of maintaining the roadway as demanded by the local authorities to facilitate vehicular traffic, and it should not be forgotten that the cost of maintaining any roadway subject to vehicular traffic is always in excess of maintenance costs where vehicular traffic does not occur on the railway roadway. Consequently for the case of a railway whose tracks are upon a public highway we have two additional costs which are: (1) That of maintaining a paved or macadamized roadway for vehicular traffic. (2) That extra cost of maintaining a roadway, such as cost of surfacing, alignment, etc., due to the additional use of the roadway by all kinds of vehicles. To the foregoing debits against the tracks upon public highways must generally be added the annual payment exacted for the use of the highway known as "compensation." In several instances which I have investigated the two accounts were about equal, leaving no doubt as to which scheme to adopt, as in the one case the company would have nothing for its money, while in the other it would have had a real estate asset which would constantly increase in value. In addition there would be eliminated the uncertain, constantly increasing, and constantly more serious claims on account of accidents, due to collisions, etc., on account of the development of the territory and the constantly increasing use of the railroad by the public together with consequent greater use of the highways by the public.

The foregoing has reference especially to the physical details of the permanent way of the highest type of the coming high speed electric railroads which will play such an important part, not only in the imminent necessary readjustment and distribution of congested populations, but in the future economic processes and development as well. At present and for a while the coming high-speed general traffic, interurban and suburban electric railways will be, in most cases, passenger transportation enterprises. That such systems are, however, destined to be important factors in the transportation of goods and merchandise admits of no doubt whatever.

The freight and express traffic of existing interurban electric roads has been shown by the experience of the interurban lines in the United States and elsewhere, to be a profitable portion of their business and one which bids fair to develop enormously. It is difficult yet to obtain any satisfactory figures as to just what this business will amount to, but from the information available from the roads investigated, a fair present average on a good road shows that it is now from $500 to $1,000 per annum per mile of single track, depending upon local conditions and the extent to which the freight and express business has been sought and developed. There is no doubt but that the same reason which has developed the passenger business on electric lines, that is, short headway, will be and is a large factor in developing the freight and express business. With steam railways the object is to make every freight train unit a self-supporting or paying unit, which is also, as is well known, the process sought to be followed by steam roads in their passenger business. Steam railway operating economy now lies in the direction of long trains, or in other words, in long headways, and the tendency of modern steam railway economy is toward building larger and heavier freight engines, and cutting down grades and eliminating curves so as to reduce the cost of the "ton-mile," etc.

In the case of electric roads the unit at present is not the ton-mile, but the car-mile, and there is practically no economy to be gained by running long trains. It has been demonstrated that passengers can be profitably carried for less per mile on interurban roads paralleling steam roads than the steam roads have been able to carry such passengers for. This condition is due to the fact that electric roads operate single cars or trains at frequent intervals, and increase the «riding habit.» The same law holds good in freight transportation. If the commercial interests of a community realized that they could replenish their stocks upon a day's notice, they would cease laying in supplies of goods of such quantity that would last them a week or ten days, or possibly two weeks, as is now the case, and through the saving thus secured in insurance, interest, warehouse handling, etc., could afford and would pay a higher rate to the electric road for the «express» handling of goods than that now paid to steam railway companies. In other words, a rapid and frequent train service, such as electric roads can give, will not only materially increase the freight and express business, but by eliminating the economically non-productive conditions now existing between the producers and the consumers will develop a most important landmark in political economy.

It is an unfortunate fact that engineers and others who have had to do with heavy duty and high-speed electric traction enterprises have not at all appreciated the economic relations maintaining between various relatively high schedule speeds and the costs of establishing and maintaining such schedules. The proof of this ignorance of the costs of high schedule speeds is to be found in the numerous general specifications for high speed electric railways wherein are to be found the provision that:

> The schedule speed of the train units shall be .... miles per hour, allowing .... seconds for stops at stations, averaging .... miles apart.

While it is true that high-speed railways are now economic imperatives in and around large commercial centres of population, it should never be forgotten that very high schedule speeds with frequent stops are expensive, and, therefore, only warranted in special cases. The schedule speed affects not only the cost of the motor equipment, but also that of the main generating station, transmission system, and other details. For this reason the matter of the proper schedule speed should always be carefully and exhaustively investigated and determined before it is announced. The scientific method of procedure consists in first making a rough preliminary determination by assuming the line to be straight and level and the stations or stops at equal distances apart. By assuming certain safe and practically standard data, such as tractive effort, braking effort, time of stops, and train friction, and having the distance between stations, a set of roughly approximated speed time, distance time, and energy curves, can be calculated and therefrom approximations obtained of the energy which will be required to maintain various resulting schedules, and therefrom a set of approximate conditions selected upon which to base the determination of an accurate set of speed-time and energy curves in the construction of which is considered and represented and determined the influence of all the details of alignment, gradients, and stops of the line as surveyed.

Two or three *actual* and *accurate* total run sheets, for runs in both directions between termini, should be constructed before attempting to arrive at a conclusion as to the most economic schedule to adopt. Plates I, II, and III show examples of sections of actual total runs or individual runs, between two stations, of such accurate determinations, made in connection with the development of the engineering details of the New York & Port Chester Railroad. Such curves also give valuable information relating to the proper gearing of any given equipment for the work it will be called upon to do. Generally speaking, it will be found that motors should be geared for the lowest maximum speed, allowing a fair margin for occasional required increases due to the necessity of making up lost time, for the making of the required schedule. A gear ratio giving an unnecessarily high speed not only overheats the motors, but produces unnecessarily great demands upon the transmission system and the generating and sub-stations.

In determining upon a schedule, not only must the matter of motor heating be considered as affected by different rates of acceleration, but there must also be considered and determined the matters of the line fluctuations together with those of energy, input and station loads. While rapid accelerations effect marked energy savings, it is entirely possible to wipe out any advantage so obtained on account of the poorer boiler, engine, and generator economies due to irregular load curves and low power factors.

TABLE I.

Distance between stops		Watt hours per ton mile for schedule speeds of					
Miles	Feet	40 miles per hr.	35 miles per hr.	30 miles per hr.	25 miles per hr.	20 miles per hr.	15 miles per hr.
3	15,840	110	80	78	65	53	40
2½	13,200	121	90	83	74	54	40
2	10,560	142	99	86	80	60	41
1½	7,920	....	123	95	85	68	43
1	5,280	....	....	128	90	74	50
½	2,640	....	....	....	145	119	56
¼	1,320	....	....	....	....	....	120
Train friction in pounds per ton		35	30	27.5	25	20	15

The braking effort or retardation is taken at 150 pounds per ton.

The stops are taken at 15 seconds each, except in the case of the 15-mile per hour schedule, where 10 seconds is taken.

The foregoing figures are for cases of approximately level and approximately straight roads.

For a schedule of 40 miles per hour the speed attained will be between 60 and 65 miles per hour. A schedule of 25 miles will require speeds of from 40 to 50 miles per hour, etc.

The rate of acceleration for the long runs varies from 75 to 110 pounds per ton, going as high as 210 pounds per ton for short runs.

The foregoing applies to single car units. If units of more than one car be used, the friction in pounds per ton will decrease and with it will also decrease the energy consumption in watt hours per ton mile.

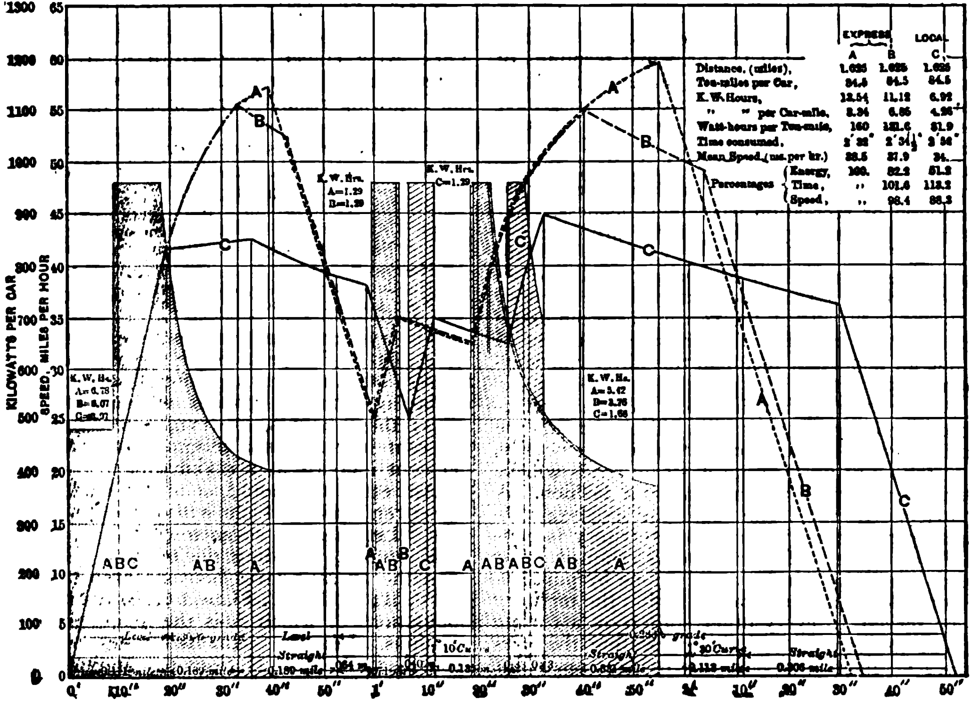
Some of the places have been left blank on account of the impracticability, with existing apparatus, of making some of the high schedules with the short distances between stops assumed in the table.

The figures are for the energy required at the motors.

Table I shows, strikingly, the relations existing between schedule speed, stops per mile, and corresponding energy consumption. In the face of the conditions shown in the table it is difficult to imagine why the matter of schedule speeds has been handled so recklessly by engineers and promoters inaugurating new enterprises.

In view of the rapidly increasing maximum speeds at which interurban systems are being operated, attention must also be paid to those details of design which will reduce the train resistance and more especially that element thereof known as "wind resistance," which is by far the greatest component of train resistance. Smooth, flat sides with the platform ends rounded or tapered and enclosed are among the simple and effective methods of car construction employed. It is astonishing what a saving in watt-hours per ton mile or per car mile and consequently, in cost of operation, the application of the simple methods above suggested will produce as indicated by recent tests.

PLATE II.



	EXPRESS A	EXPRESS B	LOCAL C
Distance. (miles),	1.625	1.625	1.625
Ton-miles per Car,	84.6	84.5	84.5
K. W. Hours,	13.54	11.12	6.92
" " per Car-mile,	8.34	6.85	4.26
Watt-hours per Ton-mile,	160	131.6	81.9
Time consumed,	2' 32"	2' 34½"	2' 52"
Mean Speed (ms. per hr.)	38.5	37.9	34.
Percentages: Energy,	100.	82.2	51.2
Percentages: Time,	"	101.6	113.2
Percentages: Speed,	"	98.4	88.3

Actual comparative run curves showing economic results of different schedule speeds. Compare table at right.

The problem of determining the total amount of mechanical resistance opposed to the motion of a car or train is a very difficult one, for which it may be said, in fact, that no general solution applicable to all cases has thus far been found. It has been generally admitted, for a long time, that this resistance, to which the general term "train resistance" has been applied, varies with the speed of a car or train; but there is a wide difference of opinion in regard to the amount of variation to be expected at different speeds. Many "formulæ" for calculating the train resistance as a function of the speed have been proposed and used. J. A. F. Aspinall, in his paper on 'Train Resistance,' read before the Institution of Civil Engineers, in 1901, tabulated no less than 55 such formulæ. A complete list would doubtless include twice that number. These formulæ differ greatly in their form and in the purpose for which they are intended. In some cases, the formula is intended to give the total resistance, including that of the locomotive and the cars constituting the train. In other cases the formula gives only the resistance of the train. In some cases the formula takes into account only the velocity of the train; in other cases the formula takes into account the number of cars, and the weight and the length of the cars in the train.

It is apparent that the matter of schedule speeds, as related to costs of operation, is not generally understood.

The schedule speed may be a large factor in determining the commercial success or failure of an enterprise. As an illustration see Table I) we see that the watt-hours per ton-mile, allowing a stop every two miles, required for a 40-mile per hour schedule, are 142, while for a 35-mile per hour schedule there are required about 99 watt-hours per ton-mile. We assume, as an average, a road 30 miles long, over which are made 100 round trips per day, with cars weighing 45 tons each, and assuming a loss of 25 per cent between the motors and the main power station switchboard, and taking the cost of energy at $.006 per kilowatt hour we have

$$\frac{100 \times 30 \times 2 \times 45 \times 0.006 \times 365 \times 142}{0.75 \times 1000} = \$111{,}952.80$$

as the cost of operating the 40-mile per hour schedule with single units and

$$\frac{100 \times 30 \times 2 \times 45 \times 0.006 \times 365 \times 99}{0.75 \times 1000} = \$78{,}051.60$$

as the cost of operating the 35-mile per hour schedule with single units.

The difference between these costs is $33,901.20, which, at 5 per cent, is the annual interest on $678,024. For a road 30 miles in length, the time between termini for the 35-mile schedule would be 51.4 minutes, while the time for the 40-mile schedule would be 45 minutes; a difference per trip of 6.4 minutes. The matter is also well brought out in the "run curves" shown in plates I, II, and III.

Earnings.— One of the most serious and inexcusable mistakes is that of computing or determining the probable gross income of a proposed new railway enterprise by the application of general average data to a specific case. The proper determination of the probable gross earnings for each or any case requires specific determinations and studies of the territory considered which will show: (1) Estimate and money value of probable passenger business between each of the centres of population and the principal terminus or termini, if both be important places. (2) Estimate and money value of probable passenger business between each of the centres of population between the termini and each of the remainder of such centres of population. (3) Estimate and money value of the probable annual excursion or recreation passenger business. (4) Estimate and money value of the probable express and freight business. (5) Rates of fare which are proposed to be charged. Should an existing road or roads be occupying the territory proposed to be served, the relation between existing rates of fare and the proposed rates is of course an important factor in this latter consideration.

As a matter of fact, instances of totally unoccupied territory are very rare. Trolley roads are almost certain to be in operation and, generally, in instances of most promise, steam roads will be found serving the territory after a fashion. A knowledge of the business of the existing railways operating in the proposed territory is generally of value and should be ascertained. For steam roads this can be readily done by purchasing one ticket, at each station within the territory to be served, to every other station on a certain day of the month, and then repeating the purchases at given intervals, say 10 days apart for some months. As each ticket has a serial number the existing local and through passenger business for any territory can be readily determined by noting the serial numbers and subtracting the numbers on those first purchased from those last purchased. This method will also show the variations of the passenger traffic.

The business of the surface trolley roads can be determined by stationing men at predetermined important places along the routes and noting the car number, time of day and number of passengers on each car as it passes a given point. For this work some experience is necessary to estimate the number of passengers on the car as it passes the observer. It is remarkable how accurate a little experience and care will make such observations. The difference in the number of passengers on a car as shown by the observations of the consecutive observers will show, approximately, the amount of local business or business between centres of population. These observations will also show, approximately, the total trolley passenger business for the territory and will provide data from and for the actual case in hand, from which can be determined the rides per capita between the different centres of population. It is needless to say that the detailed data above noted will not be supplied by the existing operating railways, whence the necessity for the relatively large expenditure of the time and money to secure them. Should the proposed railway be one of great magnitude which will involve the expenditure of large sums for its installation, it is best to extend the observations over both the summer and winter months, as by so doing a more reliable average will be obtained.

Having now the approximate actual existing traffic business between each of the towns and the termini, as well as the local traffic between each of the towns, an estimate is made of the probable increase of traffic due to the increased facilities. Upon three branches of the New York, New Haven & Hartford Railroad which were changed from steam to electric systems, the following results were obtained:

COMPARISON OF PASSENGERS CARRIED PER ANNUM UPON CHANGING FROM STEAM TO ELECTRIC OPERATION.

Name of road	Passengers carried per annum operating by Steam	Electricity
Nantasket branch	304,292	702,419
Highland divison	387,695	1,060,617
New Canaan branch	98,302	184,728

The systems cited, at the time these results were obtained, operated on hourly and half-hourly schedules. The differences would undoubtedly be much greater with shorter headways; these figures, however, show nearly 100 per cent increase as a minimum and about 270 per cent increase as a maximum.

An estimate should now be made of the passenger traffic which will come to the new road. Let there be seven towns, as A, B, C, D, E, F, and G, including the termini. Determine upon the average fares between each place, and let A′, B′, C′, D′, E′, F′, and G′ be the respective populations of which A is the main or principal terminus. Let the estimated rides per capita from G to A equal N rides per annum, and the rate of fare between A and G equal R, then $G' \times N \times R = S$, which is the revenue which will accrue on account of the community of interest between G, the minor terminus, and A, the principal terminus. Proceeding in this manner for each town or population centre, we obtain the total estimated revenue. As a concrete instance will be more impressive, attention is directed to Tables II and III showing computations of this kind worked out by the writer. earnings per capita taken from interurban statis-

Table II is computed from data upon the tics, which data were, however, not used until the existing railway earnings per capita for the case in hand had been determined by ascertaining the existing business. The railway earnings of places relatively remote from a large city are generally greater per capita for interurban railroads than those of the nearer places.

The above estimates of the earnings were made after a careful study of existing conditions, as well as of the nearest existing approximations, in the territory to be served by the New York &

Port Chester Railroad. These investigations covered many months and had for their objects:

1. A careful study, after personal observation, of the habits of the people along the line; that is, ascertaining how, when, and where they traveled.
2. The existing inducements which would cause people to travel between the various cities and towns.
3. Ascertaining the occupations of the people and the probable stability of their employment.
4. Examination of the national censuses, as well as of the various ward, precinct, and school censuses.
5. Personal observations at the various points at which the public boarded trolley cars, at all hours of the day and night for many months, to count and ascertain the amount and division of the existing travel.

TABLE II.—ESTIMATES OF EARNINGS ON POPULATION BASIS.

Between	Population carried per year	Average fare per trip	Annual income
Port Chester and New York	7,000 x 120	15 cents	$126,000
Harrison, Rye and New York	2,000 x 120	15 "	36,000
Mamaroneck and New York	5,000 x 120	12 "	72,000
New Rochelle, Larchmont and New York	20,000 x 150	10 "	300,000
New Rochelle and Port Chester	30,000 x 60	5 "	90,000
Mount Vernon, Pelham and New York	28,000 x 150	6 "	252,000
New Rochelle and Mount Vernon	35,000 x 30	5 "	52,500
Mount Vernon and Port Chester	62,000 x 20	7 "	86,800
Bronx and Mount Vernon	100,000 x 50	5 "	250,000
Annual summer and recreation business of the road	1,500,000	15 "	225,000
Total passenger income per year			$1,490,300

A careful study of the business of the existing trolley and elevated roads and steam railroads operating in the district was made, as well as of the nearest existing approximations now operating elsewhere, and all data thus obtained were plotted, and therefrom the deductions here shown were drawn. It was found that this estimate contemplates carrying the population served approximately 100 times per year. The business will include 18,000,000 fares per annum. As these 18,000,000 fares are based upon approximately 4,500,000 car miles, it will be seen that there must be carried but four passengers per car mile; 18,000,000 divided by 365=49,300 passengers per day of 398 trips, or an average of 124 passengers per complete trip of about 22 miles. There are 22 local stations and 12 express stations, which would give, on an average, 6 passengers per station per trip for the local service, and 10 passengers per station per trip for the express service.

TABLE III.—ESTIMATES OF EARNINGS ON PER CAPITA BASIS BY DIVIDING TERRITORY INTO ZONES.

Between	Population	Earnings per capita	Total
Port Chester and New York	8,000	$15.00	$120,000
Harrison, Rye and New York	2,000	15.00	30,000
Mamaroneck and New York	5,000	15.00	75,000
New Rochelle, Larchmont and New York	20,000	12.00	240,000
Mount Vernon, Pelham and New York	30,000	10.00	300,000
New Rochelle and Port Chester	30,000	3.00	90,000
New Rochelle and Mount Vernon	45,000	3.00	125,000
Mount Vernon and Port Chester	80,000	1.50	120,000
Port Chester, Bronx and Mount Vernon	100,000	3.00	$300,000
Total			$1,410,000

Table III was worked out upon the zone system and for the purposes of checking the results given in Table II. Both methods can be used and should be in all cases of this kind where a careful study of the question of probable traffic is important. The figures obtained differ slightly from those reached on the population basis, but approximate so closely as to afford a satisfactory check.

In arriving at the probable earnings per capita, per annum (Table III), a careful study was made of the average railway fare expenditures per capita as they now exist in this territory, that is, the approximate amounts of money paid to the existing steam and trolley roads by the residents of the different zones into which the district was divided for this purpose. In following out this method, 132d Street and Willis Avenue of New York city was taken as the centre, and circles with 132d Street and Willis Avenue as a centre were drawn, the radius of each circle being one mile greater than the other. In this way 25 circles were obtained. Had the circles simply been carried to the State line, but 24 would have been obtained. Inasmuch, however, as there is quite an extensive population immediately beyond Port Chester, Conn., all of which will have easy access to this road by using the existing trolley roads for a short distance, the Connecticut population was taken into account for a distance of three miles from what would be the end of this road. The population for one half of a mile on each side of this railway was obtained for each of the zones, that is, the distance between any two consecutive circles, and the riding data of this population determined. For the purpose of arriving at this information, a careful count during the summer and winter was made for a period extending over six months, of the number of passengers on the trolley cars at different points in this territory, as well as the number of people using the steam road at each of the stations in the territory under consideration. This information was obtained in the way already described.

When it had been obtained, a series of curves were plotted, showing the relations between receipts per capita and population served for different periods, and localities or zones. From the curves so determined, the figures for the receipts per capita given in this statement were summarized. Of course the estimated earnings per capita given in this summary are less than the results actually obtained, as the figures given are those estimated for the New York & Port Chester Railroad portion of the business only.

Table IV shows some of the results which now obtain upon a number of systems operating in and about various large cities of the United States. They are all city railway systems, and

TABLE IV.—STATISTICS OF LARGE CITY PROPERTIES.

	Miles of track	Population	Gross receipts	Gross receipts per mile of track	Gross receipts per capita
Interurban Street Railway Co., New York	403	2,050,600	$20,634,548	$51,202	$10.06
Philadelphia R. T. Co., Philadelphia, Pa	475	1,293,697	14,006,915	29,492	10.98
Brooklyn R. T. Co., Brooklyn, N. Y	523	1,166,582	12,510,622	23,921	11.94
Boston Elevated Ry. Co., Boston, Mass	387	741,062	11,060,380	28,580	14.88
Pittsburg Railways Co., Pittsburg, Pa	401	a750,000	8,276,560	20,640	11.08
Chicago Union Traction Co., Chicago, Ill	303	1,698,570	7,825,120	25,825	8.35
St. Louis Transit and Suburban Co.'s	455	a750,000	7,051,244	15,497	9.40
Chicago City Railway Co., Chicago, Ill	219	1,698,570	6,367,358	29,073	8.35
United Railways of San Francisco, San Francisco, Cal	244	a375,000	5,553,904	22,762	14.81
United Railways & Electric Co., Baltimore, Md	314	508,957	5,040,270	14,241	9.90
International Railway Co., Buffalo, N. Y	353	a500,000	4,426,675	11,540	8.85
Twin City R. T. Co., Minneapolis, Minn	255	366,350	3,591,540	14,084	9.80
Detroit United Railway, Detroit, Mich	380	b303,120	3,501,754	9,215	11.55
Cincinnati Traction Co., Cincinnati, O	210	325,002	3,315,751	15,789	10.17
Milwaukee Electric Railway & Light Co., Milwaukee, Wis.	146	285,315	2,302,514	15,770	8.08

a. Local estimate of city and suburb, 1903. b. Local estimate, 1901.

with the exception of the Interurban Street Railway Company of New York, all trolley roads. In most cases, the figures for traffic are for the fiscal year 1902, while the population, unless otherwise indicated, is for 1900. The population given is that of the city in which each company operates. The column of gross receipts gives the entire receipts from passengers of the respective companies, including the receipts from branches extending outside of the city limits, so that the “gross receipts per capita” are in some cases slightly higher than they would be if they showed the receipts of the actual population served. The Brooklyn and Boston figures include the receipts from the elevated lines in those cities, as these systems in each case are operated in conjunction with the surface systems, and their receipts cannot be separated. Where there are two or more companies in the same city the “gross receipts per capita” show the gross receipts of all of the surface street railways in the city.

In cases where there are no existing steam railways serving the population to be connected by the electric lines it is advisable to count the traffic by vehicles and stages between the different centres of population for periods sufficiently long and at proper intervals to give a fair annual average. From this information and by comparison with the traffic of existing roads in similar conditions a fairly satisfactory estimate can be secured. In such comparisons the “population served” may very properly be considered to be that residing within about 1½ miles on each side of the proposed line, in cases, of course, where there is no other railway serving them. The entire population of large terminal cities should not be added to the total sought, as all the residents of such city will not be probable patrons of the railway. In making per capita comparisons of this kind between a proposed and an existing railway it is often better, where both have a large terminal city, to leave this city out of account in both instances. An even better plan, where the riding between stations on the operating road is known, is to make the comparison on the zone system, as already described.

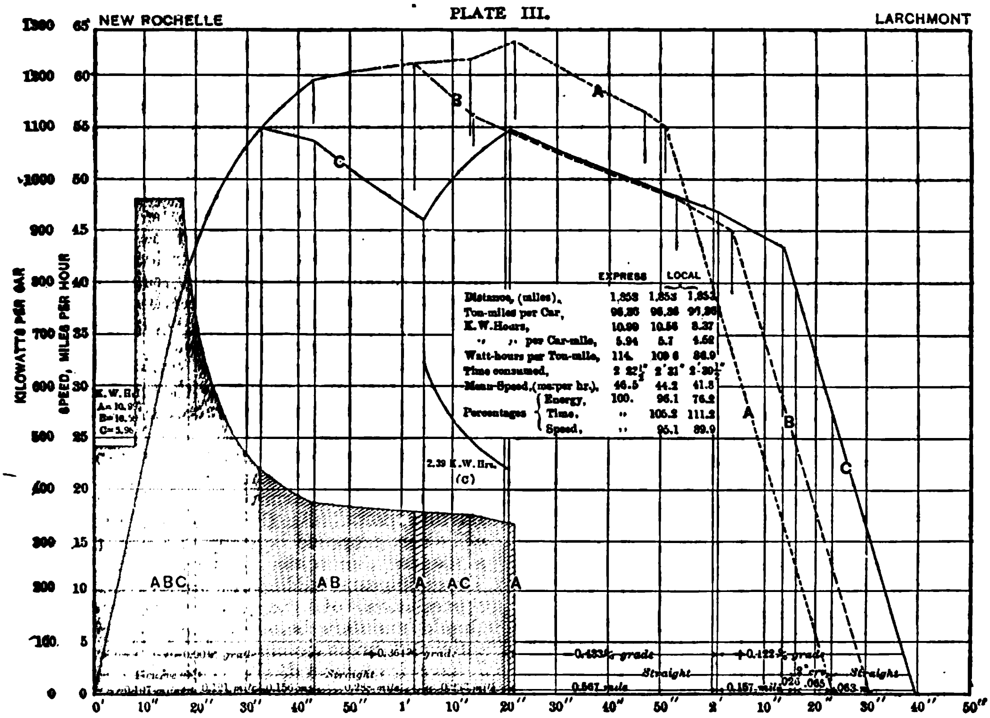
Thus far the method which should be followed in determining the probable gross passenger earnings only of any interurban system has been described. The matter of determining the gross passenger earnings has been gone into somewhat in detail, for the reason that upon roads of this character the passenger earnings at present are by far the greater portion of the total gross earnings.

In addition to passenger earnings, however, estimates should be made of the probable gross revenue which will be derived from the carrying of freight, express, and mail. The data now available on this subject are not very complete on account of the fact that this branch of the interurban business has not yet been developed and systematized sufficiently to be able to furnish accurate data. For any special case, however, the gross freight and express business can be worked out and determined by a process very similar to that used in determining the gross passenger revenue. The process consists, first, in ascertaining the amount of freight and express business coming into and going out by railway of each of the centres of population (in cases where an existing steamroad is doing this business), and then determining what proportion could be secured by the electric road. Should there be no existing steam railway, the method of procedure would be to ascertain the total production and consumption of the territory proposed to be served, which would include, of course, products of all kinds, that is, agricultural products and mining and manufacturing products. An estimate of the gross tonnage from every point along the line of the proposed road can then be made to the points at which the freight would probably be carried, such as some large city or some other connecting road.

In estimating freight traffic for towns where there is no existing road supplying the population, and, consequently, where no actual approximate railway data can be obtained for the probable ingoing and outgoing freight receipts of any single or number of population centres, another way to proceed is to ascertain the population of each of the population centres, and then have recourse to statistical data published by the United States and other governments, showing consumption and production per capita for given localities. From such data, an estimate can be made of the probable railway tonnage for the proposed road. Such an estimate will, of course, show the tonnage which would accrue on account of a service, such as is now in existence around the country, that is, the ordinary steam railway service. There is no doubt, however, but that the actual tonnage for an electric service operating frequent units would be greater than that enjoyed by existing steam roads. Instances often exist where freight and goods are taken out and into a community by means of wagons plying to and from railway centres distant anywhere from 5 to 10 miles from the community. Where such cases exist fairly accurate data can be obtained by ascertaining the business which is done by such wagon service.

There is no doubt that such relatively high-speed, high-class interurban electric railway systems which are here being considered and which are to play an important if not revolutionary part in transportation economics, will soon attain gross passenger earnings of from $12,000 to $15,000 per mile of single track per year and more, and will also attain additional earnings from freight, express, and mail business of from $2,000 to $3,000 per mile of single track per year. This refers especially to roads operating at schedule speeds of from 30 to 40 miles per hour and more, on private rights of way, connecting large centres of population and having stations or stops from a quarter of a mile to a mile or more apart, running cars at frequent headway, and when designed and installed by competent railway experts, fitted by experience to judge of the present and future economic activities of given conditions. Already some of the better classes of electric interurban roads are obtaining $10,000 to $12,000 per mile of single track per year from passengers, and $1,000 to $1,200 per mile of single track per year from freight and express, and this in cases where the whole or the major part of the tracks are on public highways, and where, consequently, the schedules are limited to 16 or 20 miles per hour, which is a perpetual handicap to interurban high-speed railways so designed and installed.

PLATE III.



	EXPRESS	LOCAL	
Distance, (miles),	1.853	1.853	1.853
Ton-miles per Car,	96.26	96.26	91.96
K.W.Hours,	10.99	10.56	8.37
,, ,, per Car-mile,	5.94	5.7	4.52
Watt-hours per Ton-mile,	114.	109.6	86.9
Time consumed,	2' 22½"	2' 31"	2' 30½"
Mean-Speed, (m. per hr.),	46.5	44.2	41.8
Percentages { Energy,	100.	96.1	76.2
Percentages { Time,	,,	106.2	111.2
Percentages { Speed,	,,	95.1	89.9

Comparative run curves determined for an actual case showing economic results of different schedule speeds. See and compare table in centre.

Expenses.— In connection with electric railway operation, an unfortunate habit has developed of estimating the annual costs of operation and maintenance as a percentage of the gross receipts. Estimates of this kind really mean nothing and have no real value even for comparisons. They are even dangerous when used in such computations and determinations as discussed here, on account of the difference in conditions, such as number of cars operated, length of route, headway, average distance each passenger is carried, and tributary population per mile of track, and especially relative receipts, etc. In order to use the percentage of the gross receipts method in making comparisons, some of the details of operation should accompany the statement of the percentage of gross receipts required to operate the road. Such accompanying details should show: (1) The gross receipts. (2) The car mileage operated daily and yearly. (3) The average daily mileage per car. (4) The total number of miles of single track operated. (5) The amounts annually expended for maintenance of way and structures, and maintenance of equipment, and the amounts per car mile for these items. (6) The physical condition of the property. (7) The capital liabilities and fixed charges. (8) Traffic density or passengers carried per car mile.

Of two roads having approximately the same amount of track, the one operating at the larger percentage of the gross receipts may have the larger net. Suppose one of two such roads to have gross receipts of $1,500,000, and to be operating at 60 per cent of its gross receipts. Suppose the second of the two to have gross receipts of $900,000, and to be operating at 50 per cent of its gross receipts. In the first case, the net will be $600,000, while in the second case it will be but $450,000. If each has approximately the same amount of track, the fixed charges will probably be nearly the same. This instance will show the necessity for additional detail if such data are used.

The only safe way to proceed is to determine the detail cost of each item entering into the total cost of operation. The subject is generally divided into four subdivisions by existing steam and some electric systems, as follows: (1) Cost of maintenance of roadway and structures. (2) Cost of maintenance of equipment. (3) Cost of conducting transportation. (4) General expense.

Any item of operating costs can be classified under one of the four heads above given. It is more satisfactory to use the following subdivision for electric systems:

1. Cost of train crews.
2. Cost of station men, such as ticket agents, etc.
3. Maintenance and inspection of cars and equipment.
4. Maintenance of roadway and structures.
5. Cost of operating main power station, including fuel, oil waste, etc., and labor and repairs.
6. Cost of operating rotary stations.
7. Salaries of officers and clerks, etc.

TABLE V.— APPROXIMATE COSTS PER MILE OF SINGLE TRACK.

Items	Maximum	Minimum
Rails, 80 lb. T ($33 per ton delivered, including splice plates, bolts, spikes, and drilling)	$5,100.00	$4,460.00
Cost of labor for handling and laying	900.00	900.00
Track bonding	1,750.00	1,400.00
Ties, 6 x 8 x 8, at 70 cents each	1,848.00 (2-foot centres)	1,474.00 (30-inch centres)
Rock ballast, 10 inches deep, 11 feet wide, and carried to top of tie	4,125.00	2,062.50
Graduation	6,000.00 (Crushed stone $1.50 per yard) (20,000 cubic yards per mile of track)	1,800.00 (Crushed stone, 75c. per yard) (10,000 cu. yds. per mile of track)
Third rail	7,000.00	3,400.00
Copper or other electrical conductors, and installation thereof	2,500.00	1,500.00
Bridges and culverts	12,000.00	4,000.00
Labor and incidentals	400.00	200.00
EQUIPMENT		
Rolling stock, motors, and equipment from $10,000 to $5,000 per car	8,000.00 (At five minute headway)	1,000.00 (At one hour headway)
Power-stations at $100 per kilowatt, substations at $40 per kilowatt, etc.	18,000.00	4,000.00
Incidentals, including block-signal system, telephone and telegraph, fencing, etc.	4,000.00	1,000.00
Real estate for right of way	20,000.00	1,600.00
Total	$90,623.00	$27,796.50

Each factor of each of the foregoing items should be carefully computed and the total cost of operation and maintenance thus ascertained. This is the only safe and true way of arriving at a proper conclusion.

The fixed charges include the following items: (1) Interest on bonds or other interest-carrying obligations. (2) Cost of leaseholds or rentals. (3) State and other taxes. Taxes are often placed under the head of operating expenses. They are sometimes determined as a percentage (from 2 to 5 per cent) of the gross receipts. Space will not permit an extended discussion of the details of the computations of the costs of construction and equipment. Table V. will give data from which such costs can be determined. In each instance, however, every item of the cost of construction and equipment must be computed and determined.

Equipment.— Among the most important and trying economic questions relating to the design, construction, and operation of high-speed electric railways reaching well out of the congested centres of population, which the designing and managing engineers are called upon to decide, are those relating to the character of construction and equipment to be adopted, and the character and kind of service to be given. These considerations may be stated as follows: (1) Number of tracks to be installed. (2) Speed, headway, and size of the train units. (3) Weight of rails and characteristics as affecting costs, of ties, ballast, block signal system, and other details of permanent way. (4) Character of rolling stock and power stations and transmission system, together with the location, design and number and character of the passenger stations.

All of the foregoing are functions of the estimated gross earnings of the proposed installation. The earnings must be taken as the starting point. At the present time the plans of some proposed systems appear to indicate a tendency, in some instances, to do too much. There appears to be, in some cases, a lack of appreciation of the proper relations which should maintain between fixed charges and the estimated gross receipts. In some cases, which I have investigated, the fixed charges upon installations, as proposed, equal 40 per cent to 50 per cent of the estimated gross receipts, a margin far too close for safety. For the cases of a number of the higher class steam roads in operation the fixed charges are found to vary between 20 per cent and 30 per cent of their actual receipts. On account of the demonstrated ability of electric systems to develop business more rapidly than their steam predecessors the above ratio of the steam lines may at times be exceeded in such cases where the estimated earnings have been conservatively made by experienced engineers. It is always best, however, to keep on the safe side, and let the earnings, after the proposed system is operating, do something toward augmenting the installation. If this latter course be followed it is safe to say that the officers and stockholders of the company will not have nearly as many sleepless nights as they otherwise may have should they too ambitiously "reach out and lead." In addition, there will probably be less activity in the receivership and absorbing and reorganization businesses.

Generally speaking, the idea should be to install no more tracks than can be kept busy safely and satisfactorily, taking care of the business in sight and which apparently will accrue from the first few years of development, on account of the increased or improved facilities proposed to be given. Relatively high speed for these roads must be maintained. Again, in attempting to get as much out of a pair of tracks (single-track roads being out of the question) as possible, it must not be lost sight of that while the capacity of a given installation with a given schedule speed can be increased by gradually adding train units up to a certain point, a limit will be reached, after which, on account of the headway requirements, any increase in the number of units will necessitate a reduction of the schedule speed, and if carried far enough, the carrying capacity will be actually reduced; any material reduction of schedule speed will probably also cause a loss of traffic. If a schedule speed of 30 miles per hour has been determined upon as that which will be required for a given territory, the idea should be to ascertain the maximum capacity of say two tracks for the proposed road when operating at that schedule. If it be ascertained that the two tracks will not be sufficient, at the determined schedule to carry the maximum estimated business, then a third track, to be used for express trains going one way during the morning and the other way in the evening, should be estimated upon. It will generally be found that wherever a third track is warranted the conditions will generally admit of the small additional outlay required for a fourth track. The additional costs are those required for the relatively slight additional graduation (earth and rock-work) and the additional rails, ties, and ballast, and the labor of installation. In cases of supplying the suburbs of such cities as New York, Boston, Paris, London, Berlin, Chicago, and San Francisco, and similar cities, it will generally be a question of determining whether two tracks or four tracks should be installed, and the safe and conservative solution will always be arrived at by considering the comparative ratio of the different fixed charges, which two, three or four tracks will impose to the probable gross receipts, estimating the gross receipts for the conditions which will exist when the road commences operation. In some instances, where a rapid growth and development is apparent, such future development must be allowed for in the original design.

As an illustration of the application of the foregoing principles suppose the estimated gross receipts of a proposed road are $900,000 per annum. Suppose, furthermore, that a two-track road could be installed to do this business for $5,000,000, and that a four-track road would cost $6,000,000. The fixed charges for the two-track road, at 5 per cent, will be $250,000 per year, while on the same basis, those for the four-track road will be $300,000. The annual operating expenses, taxes, and insurance would be about $500,000, for the conditions assumed for the two-track road, leaving for the two-track road $400,000 for fixed charges, etc. Deducting the $250,000 fixed charges of the two-track road would leave $150,000 annually to be applied to unforeseen contingencies, betterments, and other accounts. If we assume that we will run approximately the same number of train units between the termini daily for the four-track road at the start, the operating costs will be about the same. In order to justify such an assumption it would, of course, be necessary to reduce slightly the schedule of the two-track road, which can at times be done. For the case of the four-track road we will then have left, after deducting say $525,000 for the annual cost of operation, taxes, and insurance, the sum of $375,000 for fixed charges, etc. If we now deduct the fixed charges of $300,000, we have left $75,000 for unforeseen contingencies, bad times, betterments, and other accounts, a margin which is somewhat too small for the solid comfort of the bondholders and the stockholders, especially that of the stockholders. In fact, an enterprise starting upon its career upon the last basis might well be called a "receiver's delight," a "reorganizer's joy," or a "stockholder's obsequies" installation. A four-track installation for the case we have assumed would only be justified where a great immediate development along the line of the road was apparent. Even then the engineer should prepare statements of both conditions, as above outlined, and submit them to the bankers or underwriters so that they will have full knowledge of the relative conditions and contingencies.

The development of large cities and the consequent apparent exceeding of the capacity limits of some existing rapid transit or urban rapid transit system has offered opportunity for much lay, semi-professional, and even so-called engineering criticism of the shortsightedness of the originators of such transportation systems in not installing more tracks at the time of the original construction. If such critics will investigate they will ascertain that, generally speaking, such roads have been hard pressed for many years to make ends meet, and that they are now only reaping their hard-earned fruits. A little thought will also show that had such systems at the outset provided installations adequate to do the business they are now receiving, they would certainly, in years past, have suffered financial difficulties, to state it mildly. As a general rule promoters and financiers are fairly healthy, and in cases where they are not entirely so there are other and milder means than that of placing large amounts of money in relatively certain jeopardy, by reaching out and leading, of recruiting their exhausted energies.

The very best materials and construction only should be employed for the permanent way and the rolling stock, as it is only by so doing that the maximum safety can be assured to the traveling public, which must always predominate in considering costs of construction. Accidents are always costly, as are also conditions of uncertain operation and delays. The public will not patronize a road upon which accidents are frequent or whereon uncertainty of operation or delay is at all marked. Inferior permanent way and rolling stock is, therefore, equivalent to burning the candle at both ends on account of the natural reduction of receipts, for the reasons stated above, and the additional increase of operating and maintenance costs which maintain on poorly engineered and poorly installed railways.

Regarding the determination of the details of the passenger station. It should never be lost sight of that the location of the passenger stations may have a material influence upon the business which the road will do, depending upon whether the stations are located so as to render them easy of access or otherwise. The matters of the general design, size, finish and specific details of the station will have to be determined separately for each case.

In designing the stations, however, the object should be to provide stations wherein the annual aggregate salaries of ticket sellers and attendants will be a minimum. If ticket offices be placed along each side of the roadway at each station this will not be the case. The stations between the tracks on some elevated systems, known as «island stations,» are examples of the minimum operation and maintenance cost idea. About half the annual attendance is required for such stations as compared with those on each side of the tracks. The objection sometimes urged against the «island station» system is that people who are so disposed can ride back and forth any number of times after paying a single fare. In connection with the development of the engineering details, of a railroad designed by the writer in New York State, the tracks of which will be upon a private right of way throughout, and furthermore, upon earth or rock cuts or fills, the writer devised and recommended the following station plan: Wherever the roadway is on an embankment and above the grade of the streets, the station is to be constructed by providing under the roadway and approximately at right angles to the tracks, a passageway or tunnel extending entirely across and under the railway roadway, and 50 feet or more, as may be required, in width. The width of this passageway would, of course, be along the length of the tracks. In the centre of this passageway is to be one ticket office, provided with proper approaches, from each side of the roadway; and inside of and beyond the ticket office are to be waiting-rooms, etc., and the stairs ascending to the island platforms between the tracks. This underground passageway is to be of the concrete-steel construction. Where the tracks are in a cut, at station locations, and consequently beneath the surface of the streets, the design provided for a concrete-steel structure over and entirely across the tracks, wherein is located one ticket office, as before, with waiting-rooms, etc., inside the ticket office, and stairs descending to the island platforms. Stations of this kind are worth about $8,000 each. It is evident that the same plan can readily be used for a two-track road.

Where a high-speed electric railway crosses a public highway or other railway, either above or below the grade of the other road, the design of such a crossing, especially where it is below, and consists of a subway of greater or less length, may exercise considerable effect upon the subsequent cost of operation of the system, as it may determine the limiting length of the cars where trains are used. The high-speed railways herein discussed should be designed throughout so as to permit of the operation of any of the cars now used by steam railways. There is, however, another reason of essentially an economic kind. As an illustration, suppose that upon a given road it has been found that on account of the dimensions of part of the subways it will not be possible to use a car more than 40 feet in length, and that train units of three such cars will be required. It is apparent that train units consisting of two 60-foot cars would carry the same number of people as the three 40-foot cars, and allowing one conductor or guard per car, at an operating cost of one man per train unit less. It is easy to see that if train units be operated at frequent headway and for any considerable part of the day, the length of the cars becomes a most important consideration and economic factor of the subsequent costs of operation. Mistakes of the kind have occurred and are now practically the cause of considerable additional fixed costs of operation, which would have been avoided had such apparently small details been given that thorough and competent consideration at the outset which their economic importance demands.

Engineers or experts in making reports often appear to forget or ignore the fact that the essential value of their reports lies in the conclusions, and a brief statement of the bases for these conclusions. The body of a report may contain as much statistical detail and general data as may be required to pad out the document to make its outward appearance justify the fee; but the client, upon receiving the document, will generally search the index for that part of the report giving the conclusions, and the bases therefor. Often the search is in vain.

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Railway Engineering, in its broad sense, comprises the work of the civil engineer and the mechanical engineer. The first includes the design, construction, and maintenance of the statical structures, such as the track, bridges, buildings, etc., the second, the design, construction, and maintenance of the motive power, machinery, cars, marine equipment, etc. The term railway engineering is, however, usually used in a limited sense meaning the work of the civil engineer only. It is the purpose of this article to enumerate the general items of work included in railway engineering, and to state briefly the important facts, methods and principles used by the railway engineer in his work. It will be assumed that the reader is familiar with such simple terms as single track, double track, rails, cross-ties, etc., and knows the general form of a railway track in so far as a casual observation reveals it. Bridging, tunneling, and masonry, being covered elsewhere, will not be treated.

Railway Design includes the determination of the general route, and the details of the alignment and gradients of a road, called the location; the determination of the cross sectional form and dimensions of the embankments, excavations, tunnels, ballast, etc.; the determination of the form and dimensions of cross-ties, or sleepers, the form and weight of the rail and its fastenings, the necessary water way to safely pass the water of the various streams and gullies crossed, together with the form and dimensions of the culverts, trestles and bridges; the design of road crossings, grade, underhead and overhead; the design of docks, warehouses, coaling stations, water-supply works, minor buildings and yards.

Railway Construction is usually performed for the railway company by a contractor. In this case, the railway engineer lays out the work on the ground, measures the quantity of work done, and maintains a general supervision to see that the terms of the contract are complied with. The chief engineer is usually by the terms of the contract the ultimate authority out of court in the interpretation of the provisions of the contract, and he has complete control of the work done under it. When a railway company executes its own work, the engineering department devises the methods of work, secures the necessary tools and machinery, employs and supervises the labor, and in general directs the work, which is done under a superintendent of construction.

Railway Maintenance includes keeping the constructed track in good surface and alignment, from which it is distorted by the action of frost, rain, and the heavy loads going over it; replacing worn out or decayed cross ties; renewing worn out rails; keeping the drainage ditches open, grass and weeds cut, fences in repair, bridges and all other structures in repair; occasional rebuilding of whole structures; laying out and building side tracks and spur tracks to quarries, factories, gravel banks, etc., and maintenance of the water supply works.

Railway Improvement, besides the building of larger and handsomer station buildings, the purchase of larger cars and locomotives, and the improvement of station grounds and roadway, items that appeal to the general observer, includes the far more important but less conspicuous work of reducing the curvature, shortening the line, rearranging the gradients by reduction where possible and adaptation to pusher service where they may not be much reduced, and redistributing the locomotives on the road so that each one may be on that portion to which it is best adapted. This work is usually done under the combined direction of the civil and mechanical engineering departments.

Railway Alignment.— The horizontal plan of the centre line of a railway is a series of straight lines connected by curves. The straight lines are called tangents, because they are tangent to the curves joining them. Formerly these curves were arcs of circles, but they are now almost universally combinations of circular arcs and what are known as easement or transition curves, or spirals. The central portion of the curve joining two tangents is an arc of a circle of some selected radius, and between this central portion and the tangents connected by the curve are two easement curves or spirals, one for each tangent. These curves are not simple arcs of circles, but are curves having a constantly changing radius. Beginning at the tangent with a radius infinitely long, the arc just at this point being practically a straight line, the radius continually decreases, the curve becoming sharper and sharper, till it is reduced to the radius selected for the central portion of the curve at the point where the spiral joins that central portion. An easy transition from tangent to curve is thus secured, and the shock to the track and passenger greatly reduced or entirely eliminated. The circular curves are known by their degrees, that is, the number of degrees subtended at the centre of the circle by a chord of 100 feet. If a chord of 100 feet subtends 4 degrees at the centre of the circle, the curve is known as a four degree curve. The radius of a one degree curve is 5729.65 feet, usually assumed as 5,730 feet. The radius of any other curve is approximately inversely as its degree. The radius of a 10 degree curve is one tenth that of a one degree curve. This relation is not exact. A one degree curve is a very light curve, a ten degree curve about the sharpest in general use on Eastern trunk lines, a 24 degree curve about the sharpest on Western mountain lines, and 40 degree curves about the sharpest in railroad yards. Curves of 90 feet radius occur on the elevated railways of New York.

The Gauge of a railway is the cross distance between the inner sides of the heads of the rails. Standard gauge, almost universally used in the United States, is 4 feet 8½ inches. A gauge of one metre is used to some extent in the Spanish-American states, in Japan, Russia, and some other European countries. Until within a few years a gauge of 7 feet was in use in England. A gauge of 4 feet 9 inches is in limited use in the United States. A gauge of 3 feet was used to some extent in the United States, but has been almost entirely replaced with standard gauge. The transfer of the cars of one road to the tracks of another, making frequent unloading and reloading unnecessary, requires the tracks of any one continent, or country, to be of practically one gauge.

Traction is the act of drawing. That which enables a locomotive to draw a train is the friction between the driving wheels and the rails. When the pressure of the steam in the cylinders, transmitted through the connecting rod, tends to turn the driving wheels as the fly wheel of a stationary engine is turned, the friction between the wheels and the rails prevents such turning, and causes the wheels to roll along the rails carrying the locomotive and train with them. The amount of this friction varies with the condition of the rail. In summer, with a clean rail, it averages about one fourth of the insistent weight; in winter it is about one fifth; and when sand is used in summer, it may be increased to about one third of the insistent weight. Thus, if a locomotive weighs 209,000 pounds, 144,600 pounds of which is carried on the driving wheels (proportions of an existing modern heavy passenger locomotive), the average maximum pulling force that can be exerted by the locomotive in summer will be about one fourth of 144,600 pounds, or 36,150 pounds. This quantity is known as the tractive effort of adhesion. The locomotive will be able to exert this pull if the boiler and cylinder capacity is sufficient. It usually is when the speed is very low, but since a boiler is designed to give a certain maximum horsepower, when the speed is fast, the pull must be correspondingly light. Practical considerations make it impossible to design a boiler that will permit the development of the full tractive effort of adhesion at high speed. A locomotive of horsepower P, driven at a speed of S miles an hour will be able to exert a pull in pounds equal to $375\ P \div S$.

This is a theoretical value and must be discounted about 10 per cent because of frictional losses in the engine. With slow freight trains speeds of from 5 miles to 10 miles an hour may be permitted, and hence the full tractive effort of adhesion may be had on the steep grades where it is required, and greater speed may be made on the more level stretches where the tractive effort required is not so great. The most economical speed for freight trains is a disputed question. It is generally considered to be the fastest speed the train can make over the whole road or division when the locomotive is loaded with the greatest load it can draw at minimum speed on the steepest, or ruling, grades.

Train Resistance is measured by the effort required to draw a train on a straight and level track. This effort depends on the condition of the track and wheels, atmospheric temperature, the lubrication of the bearings, the direction and force of the wind, and the speed of the train. Many efforts have been made to devise a formula that shall correctly express the effort for varying speeds, but as may be inferred from the number of variable conditions, no formula giving precise values is possible. Freight train resistance is usually considered to be about 5 pounds for each ton of weight of train for usual freight train speeds of from 12 miles to 15 miles per hour. This means that if a train weighs 1,000 tons, a tractive effort of 5,000 pounds will be required to draw it on a straight and level track at usual freight train speed. To start the train will require a greater effort, because the resistance at starting is much greater than at sensible speeds. Were it not that by reason of the springs in the draught rigging the train is started a car at a time, no locomotive could start the train it habitually hauls over the track. This does not apply to fast passenger trains, the locomotives of which, being never so heavily loaded, have a surplus of tractive effort for starting quickly. Freight train resistance is least at a speed of about 6 or 8 miles an hour, and increases nearly as the speed, being about 8 or 9 pounds at 25 miles an hour. Train resistance is sometimes known as rolling resistance. There are two other sources of resistance taxing the adhesion, or tractive effort, of the locomotive, namely, grade resistance and curve resistance.

Grade Resistance is the action of gravity on a train on a grade tending to pull the train down the grade. It amounts to practically 20 pounds per ton of train weight for each per cent of grade rate. Thus, a grade rising 1 foot in 100 is a one per cent grade, and offers a resistance to an ascending train of 20 pounds for each ton of train. A grade rising 3 inches in 100 feet is a 0.25 per cent grade, and offers a resistance of 5 pounds per ton of train, or doubles the traction necessary on a straight and level track. Such a grade is considered a light grade, a 0.5 per cent grade is a moderate grade, and a 1.0 per cent grade a heavy grade, though on mountain roads in the Western United States grades of 4 per cent are common, and there are some heavier. When grades exceed 5 per cent or 6 per cent they are usually operated by cable or by specially designed locomotives carrying a gear wheel which engages in a rack built along the track. Perhaps the most elaborate cable line is the Mahanoy plane of the Philadelphia and Reading Railway, used to lift coal out of the Mahanoy Valley. Examples of rack railways are the Mount Washington Railway and the railway up Pike's Peak, planned for tourist and pleasure travel.

The Ruling Grade of a road, or division, is that grade which, because of its resistance, limits the train the locomotives used can haul. Such a grade therefore determines the number of trains necessary to do a given volume of business and is the most important feature of railway design. The ruling grade is not necessarily the steepest grade on the road. The steepest grade may occur but once, and be operated by assistant engines, a single locomotive hauling the train, heavier than it could haul unaided over the steepest grade, over the remainder of the line. Or the steepest grade may be so short that the train approaching it at high speed is carried over by the combined effort of the locomotive and the energy stored in the train by reason of its high speed. Such a grade is known as a momentum, or velocity, grade. To determine the load a given locomotive can haul on a given grade, Divide the tractive effort of the locomotive by the sum of the rolling and grade resistances, the result will be the gross load in tons. To determine the load behind the tender, Subtract from the foregoing result the weight of engine and tender. The locomotive mentioned earlier in this article, having a tractive effort of adhesion of 36,150 pounds, on a 0.25 per cent grade at low speed, could just draw a load determined by dividing 36,150 by 5 pounds per ton rolling resistance plus 5 pounds per ton grade resistance, or 10 pounds, giving 3,615 tons gross load. The total weight of such a locomotive and its loaded tender would be about 172 tons, therefore the net load behind the tender would be 3,443 tons. It is frequently claimed that an electric motor car can climb a steeper grade than can a steam locomotive, the popular belief being that some attraction between wheels and rails in the case of the electric car is the cause. It is true that an electric motor car of usual form can ascend a steeper grade than can a steam locomotive of usual form and equal weight and power. There are two reasons for this: 1. Gearing is a more certain and steadier method of transmitting power at low velocities than the reciprocating motion of steam pistons and connecting rods. 2. As usually built there is a motor on each axle of a motor car making all the wheels driving wheels, and the total weight available for traction, while a considerable proportion of the locomotive is carried on truck wheels, and hence is not only unavailable for traction, but is a direct tax on the tractive effort that is available. Assuming the high value of 10 pounds rolling resistance, an electric motor car with a motor on each axle would be just about in equilibrium, if it could start, on a 24½ per cent grade, while the locomotive mentioned earlier in this article would be in equilibrium on a 16⅓ per cent grade. No such grades could be operated. About the steepest grade operated by an electric car is 13 per cent, but such a grade is dangerous, and safety appliances should be used. The danger lies in the fact that if the wheels once begin to slip, the coefficient of friction is immediately reduced to less than one tenth, and moreover, the brakes are not infallible. Driving wheels of locomotives are seen to slip even on straight and level track, particularly at starting. This is because the great resistance to starting overcomes the adhesion, or because the engineman admits steam to the cylinders too suddenly and freely.

Assistant Engine Grades steeper than the ruling grade may be occasionally necessary to avoid great expense of construction. When such grades occur at or near a station, or yard, a switching engine may be used to help the trains up the grade, but when such grades occur out on the line, special engines must be kept at the foot of the hill. Such engines help the heavy trains over the hill and return light, without train, to the foot. To determine how steep a grade may be operated with the aid of one assistant engine of the same power as the through engine, Add the weight of the assistant engine to the weight of the through train, and find on what grade the combined tractive effort of the two engines just equals the total resistance of the entire train. The problem is just the reverse of finding the load an engine can haul on a given grade.

Momentum Grades find favor with railway managers of the Western United States and Canada, and are in operation in those portions of America, enabling heavier, and consequently fewer, trains to be run than would otherwise be necessary. Managers of heavy traffic lines in the Eastern United States regard the consideration of such grades with disfavor, holding that the accidents of traction are so great and uncertain that it is unwise to send out a locomotive with a train of greater weight than that with which the locomotive can start from rest on the steepest grade over which it must pass. The consideration of momentum grades involves two problems, one when a new line is being built, the other when re-arranging the train loads for locomotives on an existing line. The first is the determination of the length of grade, steeper than the ruling grade, that can be surmounted by a given locomotive loaded with a train proportioned for the ruling grade; the second is the determination of the weight of the train that a given locomotive, aided by velocity of approach, can carry over a grade of given rate and length. In each case the velocity with which the grade may be approached must be known. Neither of these problems is capable of exact solution, but both are capable of comparatively simple approximate solution. On an existing line a dynamometer car is of great service in studying economical locomotive loading and grade arrangement.

High Mountain Levels, if narrow ridges, may be tunneled; but if broad table-lands with steep approaches, may be reached by one of several methods adopted to secure practicable grades: (1) Zig-zag development, which means laying the line back and forth across the general direction of the route, gradually climbing the hill on a permissible grade, turning nearly a half circle at each end of a lateral stretch until the summit is reached. (2) Switch-back development, which is zig-zag development without the necessary room for turning at the ends of the lateral stretches necessitating the use of switches at these ends and the backing of the train up alternate stretches. Switch-backs must always be located in pairs to permit regaining a forward movement of trains. (3) Spirals or loops, which are formed by the line advancing in a more or less continuously curving path, constantly rising and finally crossing itself over a tunnel or bridge. Noted spirals in the United States are the Union Pacific Georgetown branch loop in Colorado, and the Southern Pacific Tehachipi loop in California. The Mount St. Gothard railway has one spiral on the Swiss side and four on the Italian side of the mountain, almost complete circles, and almost entirely in tunnel.

Curve Resistance arises from two principal causes: (1) Car wheels are fastened rigidly to the axles and hence do not turn independently. They are of practically the same diameter, and in rolling a given distance should make the same number of revolutions. But the outer rail of a curve is longer than the inner rail, and hence either the outer wheel must slip forward on the rail, the inner rail must slip backward, or both slippages must occur. (2) The direction of motion of the wheels must be constantly changing. This change is affected by the pressure of the flange of the forward outer wheel of a car truck against the side of the rail head. Both of these conditions introduce friction which must be overcome. The amount of curve resistance is not definitely known, but such observation as has been made indicates that it varies from a half pound per ton of train weight per degree of curve to two pounds per the same units. It is usually assumed at one pound. Thus, to draw a train on a 5 degree curve will require an effort of 5 pounds per ton of train weight, or as much as to draw a freight train on a straight and level track. If such a curve occur on a 0.25 per cent grade, the total effort required to draw the train will be 15 pounds per ton, 5 pounds for rolling resistance, 5 pounds for grade resistance, and 5 pounds for curve resistance. When curves occur on grades approximating the ruling grade so that the combined resistance of curve and grade exceeds that of the ruling grade alone, the grade throughout the curve is reduced sufficiently to make the total resistance no greater than that offered by the ruling grade. This is called compensating for curvature. The amount of reduction is usually 0.05 per cent for each degree of curve.

Elevation of the Outer Rail.—The passage of a train at sensible speed around a curve generates centrifugal force tending to cause the train to leave the rails or overturn. This force is greater in proportion to the square of the speed, and less as the radius of the curve is greater. It is counteracted by canting the track, usually called elevating the outer rail, so that the effect of gravity tending to pull the train down the inclined plane toward the centre of the curve shall just equal the centrifugal force generated, or rather, so that the resultant of the weight and centrifugal force shall be perpendicular to the plane of the track. It will be evident that in passing from a straight line to a curve, since the centrifugal force is instantly generated, the full theoretic cant of the track should begin at the beginning of the curve. This is possible with the modern easement curves, but was impossible with curves as formerly laid out when the circular curve was itself tangent to the straight line. The practice then was to begin the canting back some distance on the straight line, increasing it gradually till the full amount required was had at the beginning of the curve.

Cost of Operation is an important item of information to the locating engineer. He is particularly interested in the cost of running trains, usually stated by the train mile, that is, one train run one mile. From this cost known in great detail, he separates those items that vary with the physical characteristics of the road and which may therefore be influenced by his design, and endeavors to determine what additional cost would result from the addition of a mile or a foot to the length of the line, the cost resulting from the introduction of a degree of curvature, or a foot of rise and fall in the grade line, and the cost resulting from an increase in the ruling grade. Excluding fixed charges, but including all general expenses of operation, many of which are independent of the number of trains run, and even considerable variations in the physical characteristics of the track or motive power, or amount of traffic, the average cost of running one train mile in the United States is about $1.18, having increased about $0.22 since 1898, before which year the cost was practically constant, varying only a few cents for a number of years. Heavy freight trains cost from $1.20 to $1.80 or more per train mile, averaging about $1.40, while passenger trains cost from $0.75 or less, to as much as heavy freight trains, averaging about $1.10 per train mile. The cause of the increase in cost is partly due to an increase in the weight of trains of both classes, and the increased elegance and speed of fast passenger trains. Operating expense is divided into four general items, each made up of a multitude of minor items for which reference may be had to the Reports of the Interstate Commerce Commission. The four general items with their several contributions to the train mile cost are:

Maintenance of way and works....	$0.26
Maintenance of equipment........	0.225
Conducting transportation.........	0.65
General expenses.................	0.045
Total	$1.18

From the detail items above referred to the cost of operating a train unit of distance, curvature, and rise and fall, may be approximated. Based on a train mile cost of $1.00, these costs will be as an average for the United States about as follows: A train degree of curvature, $0.0006; a train foot of rise and fall, from nothing to $0.005, depending on the rate of the grade on which the rise occurs; a train foot of distance, $0.0004; a train mile of distance from $0.35 to $0.90, according to the distance. If it is estimated or known that the train mile cost on any particular road is $1.40 then the foregoing values should be multiplied by 1.4. Only heavy passenger and maximum freight trains should be considered in comparing different ruling grades, but all trains are affected by curvature, rise and fall, and distance.

Railway Revenue is a matter of importance to the railway engineer, for he must not plan a line of light traffic on so expensive a scale as one of heavy traffic. He can not spend so much to secure low grades for a line that will probably run one or two or five trains a day as for one that will probably run 10 to 50 trains daily. For the purpose of design, the probable business is best estimated by the number of daily trains, but for the purpose of reporting on the desirability of a proposed new line, the estimate must indicate the probable revenue in money. In either case the only method of making a rational estimate is to compare the producing character of the territory to be traversed, with that of some similar territory already served by a railway, and to note the revenue of that railway. To compare population is not enough; the nature of the industries to be served, or that are likely to soon follow the construction of the road, must be considered.

Railway Location consists in selecting the general route between two adopted termini, and the detail work of so fitting the line to the ground along the adopted route by judicious curvature and grades that the cost of construction shall be an economic minimum. This may be the ultimate practicable minimum, but will not ordinarily be so. The effort of the locating engineer is to so design the alignment and grades that the net difference between revenue and the sum of operating expense and interest on first cost shall be a maximum. This work requires the greatest skill and judgment of any branch of railway design. The field work of fitting the line to the ground involves ordinary surveying methods. The surveys, after a reconnaissance which determines the general route, are two, the preliminary survey and the location survey. Practice has varied as to the methods of doing the detail work, but in general the preliminary survey is a topographical survey of a belt from 200 feet to 1,000 feet wide, within which the located line will lie, furnishing a map on which a centre line is planned to fit the ground as represented on the map, and the location survey consists in placing the line, thus designed, on the ground. Two maps are always made on a location survey, one showing the horizontal alignment known as the map, another showing the vertical alignment, the grades, known as the profile. The profile shows both the undulations of the natural ground surface and the undulations of the surface along the centre line as it will be when the road is graded. Generally an effort is made to so draw the grade line on the profile that there shall be as much of the natural surface above it as is below it, thus making the portion to be cut away equal the portion to be built up by embankment. This is generally economy, but as cuts are troublesome to drain, and to keep clear from snow in northern latitudes, a road is laid out in embankment so far as is economically possible. The most important item in railway construction, after providing the necessary strength to carry the trains, is drainage. When a cut or excavation lies across the general direction of the prevailing winter winds, it is likely to collect drifts. These are sometimes prevented by building open board fences parallel with, and some distance from, the cut, causing the drift to form outside the cut. In mountainous districts subject to heavy snow drifts, the track is sometimes protected by wooden sheds entirely covering it. Many miles of such sheds occur on the Central Pacific division of the Southern Pacific Railroad through the Sierra Nevada Mountains, and on the Canadian Pacific Railroad. These snowsheds are very costly to maintain, requiring constant watchfulness to prevent fire, and the maintenance of fire fighting apparatus ready at all times. In determining the economic grades and curvature to be used, the locating engineer applies his knowledge of the facts and principles mentioned in the preceding paragraphs of this article. He determines how much he may spend to avoid a degree of curvature, how much to avoid a foot rise in the grade line, how much to shorten the line a foot or a mile, and how much to reduce the ruling grade below that which seems to give the lowest first cost; he determines where pusher grades may be introduced to advantage, and where velocity may be counted on to assist in surmounting some steep short grade that low first cost suggests. After the location is completed, and sometimes while it is yet in progress, the work of construction begins. Before this, details of rail section, cross ties, roadbed, etc., must be determined.

Railway Right of Way is the name given to the strip of land secured by the railway company for its use in building and maintaining its road. In the United States this strip is usually 100 feet wide, with additional ground for stations, shops and yards, and extra width along the line where the construction work is so heavy as to require it. Where an embankment is so high, or an excavation so deep that the base width of the one or the top width of the other is more than 100 feet, a retaining wall must be built or additional width of right of way secured. In cities it is generally advisable to build the walls, but in the country economy will be secured by buying extra right of way.

Railway Roadbed, the top of which is known as sub-grade, is from 14 feet to 18 feet wide where the road is in embankment, and from 20 feet to 26 feet wide where in excavation, for single track roads. The extra width in excavations is to provide room for drainage ditches on each side of the track. The side slopes of the embankments are usually one and one half horizontal to one vertical, which is about the angle at which ordinary earth will stand. Rock slopes may be made vertical in excavation and at 45 degrees, one to one, in embankment. Earth slopes are sometimes taken out in excavation at one to one, but they do not long stand at this slope, and the slight economy obtained in first cost is at the expense of additional cost of maintenance in keeping the ditches open.

Railway Ballast is the material in which the cross-ties are imbedded, and which serves the purpose of distributing the load on the ties over the roadbed, holding the track in place, and providing drainage for the track. The requirements for good ballast are that it shall be durable, shall yield no dust, shall be firm and porous. Fine broken stone or gravel make excellent ballast. Other materials used are furnace slag, cinders, burnt clay, and ordinary earth. In value these are about in the order given. For light traffic roads there should be not less than six inches of ballast under the ties, and for the heaviest traffic there need not be more than 16 inches. If the ballast is quite porous, as broken stone, it is carried up to the top of the tie throughout its length and a little beyond the ends, and then sloped off to the roadbed, but if it is less porous, as compact sandy or loamy gravel, it is carried up to the top of the tie, or 3 or 4 inches above it, in the middle, from where it is sloped down to the bottom of the tie at its ends, and then to the roadbed.

Railway Cross-ties are usually of wood. A few steel ties are in use, and concrete steel ties are in experimental use. A hard wood, not quickly rotted by exposure, is desirable for a wooden tie. Oak and Southern pine are much used. Chestnut, cedar, redwood, bois d'arc, Douglas fir, and other woods, are used in localities where they are readily obtainable. Untreated with preservative, railway ties of good quality will last from seven to eight years, and in the alkali soils of the Western table-lands much longer. Comparatively poor soft wood ties, preserved by Burnettizing, the Wellhouse process, or creosoting, will last from 12 to 15 years or longer, and are much more economical than hard wood ties untreated. Probably not far from 100,000,000 cross-ties are used in the United States annually. The common size is six inches deep, eight inches wide, and eight feet long. Some are larger, and a few smaller.

Railway Rail designing was formerly a matter occupying considerable attention, and many forms were devised and used. The best form is still undetermined and under consideration by eminent railway engineers, but, with a few notable exceptions, American roads use exclusively what is known as the American Society of Civil Engineers' section, and modern designing consists simply in determining the weight to be used, and the chemical composition and physical treatment of the metal. Rails are known by the weight per lineal yard of one rail. A 60 pound rail weighs 60 pounds per lineal yard and has about 6 square inches in its cross section. The rail is divided into head, web and flange; and in the Am. Soc. C. E. section, 42 per cent of the section is in the head, 21 per cent in the web, and 37 per cent in the flange whatever the weight. The principal features of this section are the proportions of the metal in the three parts, the equality of total height and base width, the vertical sides of the head, some engineers advocating heads widening downward, and the small radius curves for the upper corners of the head. The section has proven well adapted to rails of less than 80 pounds per yard, but not so well adapted to heavier sections, the reason generally assigned being that the disproportion of thickness of head and flange makes impossible continued rolling at low temperature, which is said to harden the head and make it more durable. A section designed by P. H. Dudley for the New York Central Railroad overcomes this difficulty to some extent. Other types of rail are the Sayre, designed by R. H. Sayre for the Lehigh Valley Railroad, and the Sandberg type used somewhat in Europe. The standard type of rail in Great Britain is known as a bull head rail. It has two heads instead of head and flange, and is carried in cast iron chairs in which it is fastened by wedges. It was originally designed to be reversible, but it was found that by the time the head in use was worn the head in the chair had become so battered that it could not be used. The head in the chair is now rolled only large enough to provide the necessary bearing and wedging space. Rails are generally 30 feet long, a few of each lot being one or two feet shorter. There is a tendency to increase the length of the rail in order to lessen the number of joints, and a good many 33 feet rails are in service, some 45 feet, and a few 60 feet. Heavy street railway rails are almost always rolled 60 feet long.

Rail Jointing is as yet an unsolved problem. The object to be attained is to make the track at the joint as strong, as rigid, and as flexible as other parts of the track, in short, to make the jointed track act as a continuous track. There are two types of joints, known as supported and suspended joints. In the first the abutting ends of adjacent rails are on a tie, in the second between two ties. What is known as a bridge joint is a suspended joint in which a bar or plate of metal resting on the ties adjacent to the joint supports the rail ends. Common forms of splice bars, or joints, are the ordinary angle bar splice, the continuous rail joint, the Weber joint, and two modifications of the angle bar splice, known as the Bonzano, and the 100 per cent joint. Rails are fastened to the ties by hook headed spikes. Sometimes plates known as tie plates are used between the rail and the tie, to save wear on the tie and to form a lateral brace for the rail. Rail braces are used on curves, to brace the outer rail against the pressure of the wheels, and at switches.

Switches are devices by which a train is enabled to leave one track or enter another. They consist essentially of two movable rails called switch rails, which may be set to guide the wheels to the main track or to the turnout, and a frog, which permits the flange of the wheels to cross the rail of the main track where it is crossed by the outer rail of the turnout curve. There are various kinds of safety switches and frogs, devised in general to provide an unbroken main track.

Side Tracks for passing trains must be built along single track roads at intervals depending on the traffic. They may be long enough to hold from one to four trains. The maximum length of a train is not the same on all roads nor on all divisions of one road because of differences in ruling grade and locomotive power. Lengths of side tracks will differ accordingly. It is hardly practicable on single track roads to handle trains of more than 65 to 70 cars. Such trains will require about a half mile of siding per train. Double track roads require sidings to permit fast trains to pass slow trains. Even four track roads require occasional passing sidings, and all roads require sidings at stations for handling freight.

Railway Yard is the term applied to the space occupied by a railway at a station. At principal stations, yard design, meaning the planning of the arrangement of the side tracks in the yard, is a matter of great importance, requiring experience and judgment. A design is usually the result of the combined efforts of the Chief Engineer, the Master Mechanic and the General Superintendent. Beside the necessary shop and roundhouse tracks, and tracks for the storage of cars needing repairs, or temporarily out of service, each yard will have two distinct sets of tracks, one for freight in each direction. Each set will have its incoming storage tracks, its classification tracks, on which the mixed freight of an incoming train is sorted according to its class, whether live stock, perishable goods, or other freight, and whether through or local, and its outgoing storage tracks on which the trains are made up anew for forwarding. Yards should be designed to make the movement of freight through them continuous. There are three methods of handling the cars, known as «push and pull,» «poling» and «gravity.» By the first a shifting or switch engine is coupled on the rear of a newly arrived train, pushes it ahead while a trainman uncouples the first lot of cars, called a cut, for some classification track, stops as suddenly as possible, when sufficient speed has been attained to send the cut to its proper place, pulls the remainder of the train back for a new start, and again pushes it forward, sending a second cut ahead, and so on till the whole train is distributed. The severe treatment of the cars, and the considerable total distance traveled by the engine will be apparent. By the second method, the switching engine runs on a track alongside the train to be distributed, the first cut is uncoupled, a pole is placed against the rear of the rear car of the cut and the forward end of the engine, which then pushes the cut ahead till it has attained sufficient velocity to send it to its proper place, and then returns for a second cut and so on. The lessened wear on the cars will be evident. By the third method a hump or hill is made in the track up which the engine pushes the train till the first cut is ready to run down the other side, which it is permitted to do, the incline giving it sufficient speed to carry it to its proper classification track. The first cut is followed by the second and so on. The cars are not severely used, and the engine travels simply the length of the train. Such a gravity yard furnishes the most economical method of distributing cars. If the road is a double track road, the main tracks should lie wholly without the yard, one track on each side, to avoid the necessity of any crossing of main tracks at any time. A single track road should lie on one side of the yard, the two sections of which may lap. A car once received from a main track should not touch it again till made up in a train to go forward. Comparatively few yards are well designed, having grown from small beginnings, but many new ones are being well laid out, and some old ones remodeled to conform to the requirements of increased business. Tracks in yards and sidings constitute more than one fifth of the total trackage of the United States.

Water Supply stations on busy lines occur about once in five miles and are rarely farther than 10 miles apart. In cities water is usually taken from the public supplies through suitable stand pipes or track cranes. Between cities it may be obtained from large wells, from near by streams, lakes or ponds, or from specially constructed reservoirs. An elevated wooden tank holding about 50,000 gallons or less is usually constructed at each water station. The height is sufficient to permit running water rapidly to the engine tender tank. A few roads running heavy fast passenger trains maintain track tanks, which are steel troughs about a quarter of a mile long in the centre of the track. These troughs are kept full of water by a near by pumping station, which also supplies steam and circulation to prevent freezing in winter. Water is taken by the locomotive without stopping. A scoop under the tender is lowered into the water at the beginning of the trough, and the water is forced up into the tender tank by the rapid forward movement of the locomotive. These tanks are expensive luxuries, necessary only to long distance high speed travel. In the arid districts of the West, water supply is a serious problem, solved often by the use of water trains conveying water from the nearest source to points where it must be on hand, but is not to be found. Water must be of good quality for steam making, and not infrequently is brought several miles in pipes because local water at a station is unfit for use in boilers. Various water purifying and softening processes are also in use. Water is supplied to the tanks by gravity from high storage reservoirs, or by pumps actuated by wind mills, steam, gas, or oil, engines. The cost of water supply amounts to about ⅝ of one per cent of the total cost of railway operation, or about ¾ per cent train mile.

References.— For more complete information concerning railway location, construction, and maintenance, consult Wellington, 'Economic Theory of Railway Location'; Tratman, 'Railway Track and Track Work'; Camp, 'Notes on Track'; Gillette, 'Earthwork and Its Cost'; Webb, 'Railroad Construction.' Interstate Commerce Commission Reports, and Poor, 'Manual of Railroads,' both annual publications, give data concerning cost, expenses, revenue, etc.

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Railway Freight Car Mileage in the United States. The number of miles run daily, on the average, by freight cars is an indication of their usefulness and money-earning capacity. As the freight earnings constitute 69.4 per cent. of the total earnings of railroads in the United States, it is most important to keep the cars moving, so that their mileage and their earnings will be as large as possible.

Freight car mileage is classified as loaded and empty. Usually two-thirds of the total mileage is made when the car is under load, and one-third when it is empty. Of course, only the loaded mileage produces earnings, the empty mileage being made in moving the car from point to point in seeking the load; naturally a constant effort is directed towards reducing this empty, nonproductive mileage.

Poor's Manual of the Railroads for 1909 gives the following figures:

Miles of railroad operated.......	244,084	miles
Tons of freight moved..........	1,556,559,741	tons
Tons of freight moved one mile...	218,802,986,929	ton miles
Freight cars....................	2,073,606	cars
Total mileage of freight cars.....	17,169,413,224	car miles
Freight earnings...............	$1,677,614,678	
Total earnings.................	$2,418,677,538	
Average distance each ton is hauled.....................	141.87	miles
Average number of ton miles per freight train mile............	362.57	ton miles

From these figures it is found that on an average each freight car earned $795 yearly; that it moved 8302 miles, or made that many car miles; that on the average it moved daily 22.7 miles; that during the year it carried 739 tons of freight, or 100,426 tons of freight one mile; and that there are 8.1 freight cars for each mile of railroad.

The average mileage made by freight cars is increased by long haul freight; by the prompt movement of freight after it is loaded; by a large percentage of high grade perishable stock or refrigerator car freight, which, necessarily, has to move promptly; by proper freight tracks and yards, so that the freight traffic is not delayed by the passenger traffic, or by lack of handling facilities; by the strict collection of charges for car service, so that cars are loaded and unloaded promptly; by not overloading freight trains; by a high daily rental paid for the use of cars in preference to a mileage payment; by keeping the cars and power in good repair; and by many other phases of good operation.

The mileage is influenced unfavorably by a short average freight haul; by a large percentage of low grade or slow moving freight, such as coal, which is often allowed an extra time for unloading before a charge is made for the use of the car; by poor track and yard facilities; by failure to charge and collect car service, thus allowing cars to stand under load an unduly long time; by overloading freight trains, causing delay on the road; by slow movement of freight after it is loaded; by a low mileage or day rate for payment for the use of cars; by equipment in poor condition; and many other phases of poor operation.

Naturally refrigerator cars loaded with perishable freight, which move long distances and must necessarily move promptly, make the greatest mileage, while coal, flat and gondola cars loaded with slow moving freight make the poorest.

The average mileage made with freight cars on the different roads varies from as low as ten miles to as high as 35 or 40 miles daily. The figure of 22.7 miles per car per day, which is the average made by all of the roads of the United States, appears to be very low; but then it must be remembered that the average haul is only 136 miles. Applying the daily rate of 22.7 miles to 136, we find that it gives an average of six days as the period between loading, or the time required for the round trip. When it is remembered that included in this figure of six days is the time required to load and unload the car, move it to obtain a new loading, and repair it when repairs are needed, the figure does not appear so bad. Car Service Associations usually allow two days free time for either loading or unloading a car, before a penalty is charged fot the use of the car, and if one day beyond the four thus taken up be needed to place the car for its next load, it only leaves one day in which the car must be moved, and repaired when it needs repairs.

This illustration is given to bring out strongly the point that during the greater part of the time freight cars are occupied in the loading or unloading, or by waiting for a load; that only during a small part of the time is a car actually being moved. It shows the great necessity for quickening the time required for loading and unloading, and, of course, indirectly shows the necessity for car service associations to make and collect a charge for the use of cars when too much time is taken in either loading or unloading them. That is, the way to make the greatest gain in freight car mileage is by reducing the time a car is not moving.

The average length of freight haul per ton, as has been mentioned before, greatly affects the mileage made by the cars. Poor's Manual for 1905 gives the following figures as to the average freight haul per ton, which show much variation for different parts of the country:

	MILES.
New England States	86
Middle States	109
Central Northern States	141
Gulf and Mississippi Valley States	143
Southeastern States	192
Northwestern States	209
Pacific States	213

Naturally, the New England roads cannot make as good average mileage with their cars as the roads in the Pacific States.

The following are some of the important points watched by many railroads in order to increase the mileage made by freight cars:

Monthly statements are made showing the mileage made by freight cars of the various kinds on each Superintendent's division. These statements give comparison with preceding periods, and with the performance on each other division of the system. Thus, the statement at once shows the part of the system where the poorest performance of the cars is being made, and attention is naturally directed to bettering the conditions at this point.

An effort is made to put as much business as possible in the through trains that will run long distances without switching in intermediate yards. Thus, the cars move continuously for long periods.

At all points where business originates, it is necessary to hold empty cars in order to provide for the business. A number of men are constantly employed in watching them, to see that no more than necessary are kept on hand.

At terminals the number of cars to be unloaded is carefully watched, so that, in case they accumulate faster than they can be unloaded, arrangements are made by embargo, or by reduction of the supply of empty cars at the loading point, to avoid an accumulation of loads at the unloading terminal.

An increase of ten per cent. in the mileage made by freight cars is equivalent to building that much more equipment. The building of new equipment is frequently made unnecessary by increasing the mileage of existing equipment.

C. S. Sims,
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Railway Heavy Freight Trains. The weight of freight trains in the United States has increased enormously within the last 10 years as may be seen by the following table, which shows the increases on a few of the most important roads in various sections of the country:

RAILROADS.	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904
Lehigh Valley	......	......	......	412	424	448	467	464	486	486
New York Central	......	......	290	320	361	398	392	387	421	419
Pennsylvania	......	......	......	......	470	478	481	518	527	501
Louisville & Nashville	......	......	179	194	216	239	222	231	231	234
Norfolk & Western	......	......	325	355	384	435	452	476	486	488
Chesapeake & Ohio	......	325	352	379	450	500	533	538	538	538
Southern	......	162	173	176	188	203	222	226	218	225
Illinois Central	......	......	194	191	209	222	275	325	335	332
Chicago & Northwestern	......	141	152	194	208	236	232	250	232	225
Chicago, Milwaukee & St. Paul	152	167	167	175	187	205	263	285	281	280
Lake Shore & Michigan Southern	318	322	321	352	427	455	531	577	615	588
Southern Pacific	......	......	......	220	226	240	254	261	267	275
Northern Pacific	......	......	230	313	336	391	381	401	384	403
Great Northern	......	256	281	316	336	357	381	418	447	447

In the Car Record Office at intervals of every five days the records of movement and location of cars are gone over, and the Superintendant of Car Service writes to the Agent, or Yardmaster at whose station or yard a car has been located for an unduly long time, inquiring as to the cause and suggesting the movement of the car.

Once during each month a statement is made, showing all cars which have not moved for a period of five days or more on each Superintendent's division. This statement is made so that it compares with the preceding period, and with each division. It is a constant reminder of the necessity of moving the cars,— an effort naturally being made to have each succeeding statement show fewer old cars.

Card waybills under which a car is moved are often stamped with the date of arrival of the car at any point. Thus, by looking over the card waybills is ascertained the length of time any car has been at any point, and the old cars can readily be checked.

This table gives the average weight of train in tons of 2,000 pounds hauled by the roads during this period. In some cases this is revenue tonnage, and in others total tonnage, but as the same unit is used for the figures of any one road, the proportionate increase can be easily discerned. As a rule roads lying east of the Mississippi river have not increased the weight of train is as great a proportion as the other sections, but in 1899 the trains of these eastern roads were generally heavier than those of the west, so that there was less opportunity for increase. It is also of interest to note that there has been comporatively little increase from 1902 to 1904, but there have been some very great increases within the 10-year period as, for instance, will be seen by referring to the Lake Shore record, which averaged 318 tons in 1895, and 615 tons in 1903, or nearly double, and C., M. & St. P. has accomplished nearly the same proportion of increase, but even now its train load is not as great as the Lake Shore's was 10 years ago. This is accounted for by the fact that the latter road is nearly straight, with light grades, while the former has hills that are possibly three times as steep.

We must not confuse, however, the train loads given in the table with what is actually hauled by the locomotives, as the Lake Shore road has engines which can haul 3,000 tons or more back of the tender. The figures are the average train loads for main line and branches, and, moreover, do not include the weight of the cars themselves, which may run from one half to one and one half times the load, depending upon whether it is heavy or bulky. One of the transcontinental lines recently grouped its locomotives so that trains of from 1,350 to 2,600 tons could be hauled westbound, that is, the load back of the tender lay between those limits for different portions of the line, the engines being distributed according to the grades, so that a constant train load could be taken as far as possible. The first 450 miles were of undulating profile, having .8 per cent. grades and 1,500 tons were pulled over this portion. Beyond this the grades were lighter, and with helpers at critical points the train load was 2,400 tons for a distance 600 miles. The following 500 miles had very heavy mountain grades, and even with three large engines the load was reduced to 1,500 tons. One hundred miles of descending grades permitted one engine to take 2,600 tons, but beyond this additional mountain ranges required the tonnage to be cut in half to tidewater 600 miles further. Thus the train would be broken nine times in covering 2,300 miles of road, but the profile and available locomotives did not permit of a closer adjustment. This gives some idea of the diversity of conditions with which large systems have to contend.

The partial effect attributable to increase in weight of train is shown in the following table which gives the average cost of hauling one ton, one mile in cents, during the same period. It must be remembered that there are many other items besides the weight of train which effect this cost, as variation in price of materials and labor. These latter have increased considerably within the last five years, and it will be noticed that generally the cost has risen in this period, while it fell before; but we also see that the greatest increase in tonnage per train mile was made in the previous five years.

RAILROADS.	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904
Lehigh Valley	....	.43	.42	.35	.40	.42	.41	.41	.43	.40
New York Central	....	....	....	.39	.35	.35	.38	.42	.44	.48
Pennsylvania	....	....	....	....	.34	.36	.38	.40	.43	.42
Louisville & Nashville	......	....	.58	.54	.52	.54	.50	.51	.54	.55
Norfolk & Western	....	......	.33	.28	.27	.26	,28	.27	.29	,31
Chesapeake & Ohio	....	.28	.27	.24	.23	.22	.24	.25	....	.31
Southern	....	.68	.65	.64	.63	.64	.66	.66	.70	.69
Illinois Central	.....	....	.44	.44	.45	.43	.41	.40	.39	.43
Chicago & North Western	....	.63	.60	.56	.54	.50	.51	.50	.55	.61
Chicago, Milwaukee & St. Paul	.67	.60	.61	.61	.59	.63	.57	.56	.58	.59
Lake Shore & Michigan Southern	.39	.37	.37	.34	.32	33	.34	.38	.41	42
Southern Pacific	....	....	....	.62	.62	.64	.64	.66	.68	.68
Northern Pacific	.... ..	....	.70	.50	.50	.47	.48	.46	.47	.46
Great Northern	....	.51	.53	.44	.45	.46	.48	.42	.42	.46

Examine, for instance, the Northern Pacific record, where the cost dropped from .70 to .47 between 1897 and 1900, and the train load increased from 230 to 391 tons, whereas, from 1900 to 1904 the load has only increased 12 tons (from 391 to 403), and the cost is about the same, viz., .46 cents. So, also, for the C., M. & St. P., the weight of train increased from 152 to 285 tons, and the cost dropped from 67 to 56 cents between 1895 to 1902, but since then the train load has decreased slightly and the cost has risen to .59. In this case also the lowest cost was accompanied by the heaviest train. The Illinois Central, C. & N. W., and Great Northern also show that the lowest cost corresponded to the years of heaviest train loads. Some of the other roads show a slight increase in cost in connection with a slight increase in weight of train, but this is due no doubt to heavier charges for labor and material.

In order to haul such trains much heavier locomotives are needed, and the following table gives the principal elements of the heaviest freight locomotives that were built during corresponding years as given in the engineering journals:

ITEMS.	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904
Total weight in tons	87.5	92.5	86.0	115.	110.	125.	105.	132.	142.	167.
Adhesive weight in tons	75.0	75.0	62.5	102.	92.5	112.	92.5	117.	117.	167.
Tractive force in pounds	38,000	38,000	26,000	53,000	50,000	64,000	49,000	62,000	63,000	70,000
Heating surface in square feet	2,300	2,900	2,900	3,300	3,500	3,800	3,600	5,400	4,800	5,600
Grate area	35	35	34	35	49	42	52	59	58	72

Of course, the introduction of large locomotives when purchased in considerable numbers, will have an immediate effect upon the average train load, but even if the total power of the road has a 10 per cent. increase in large engines, the general average would be but slightly raised. The C. & N. W. found that in 30 years the average tractive force of its locomotives on its lines had increased 150 per cent, which would mean a corresponding increase in train load, but we find that in ten years alone this road has nearly doubled its weight of trains. This indicates that the increased size of locomotives is not alone responsible for heavier trains, and while double heading has made some increase there is no doubt but that the system of tonnage rating is responsible for a large proportion of the increase. When locomotives are loaded by actual weight of train instead of by number of cars, as was formerly the practice, the full power of the engine can be utilized and heavier average trains can be hauled.

There are limits, however, which should be observed in this practice, and while some dispatchers thought that if a heavy train was good practice a heavier one would be still better, and loads were added until the engine could hardly ascend the maximum grades, it has been frequently demonstrated that it is not only impossible to obtain a large monthly freight movement per engine by such overloading but it is also usually a very expensive practice; that is that if we wish to obtain the greatest ton mileage from a locomotive during a period of time, and also operate at the lowest possible cost, we must usually attach a considerably lighter train than the maximum which could possibly be taken over the heavy grades.

The tractive force of simple locomotives at slow speeds (8 to 10 miles an hour) is taken as eight-tenths of the product of the boiler pressure in pounds per square inch, the square of the cylinder diameter in inches and the stroke of the piston in inches, divided by the diameter of the driving wheel in inches. This tractive force is at the rail and the weight upon the drivers must be at least four times as great as the tractive force. A train can be hauled when the resistance (including engine and tender as cars) does not exceed the tractive force.

The resistance must be figured for speed, grade and curvature and also for inertia when starting or accellerating trains. The speed resistance below 20 miles an hour can not be expressed by any regular rule, and amounts to about as follows: 5 miles an hour, 5 lbs. per ton: 10 miles an hour, 5½ lbs. per ton: 15 miles an hour, 6 lbs. per ton, and at 20 miles an hour, 7 lbs. per ton. Above this speed the resistance in pounds per ton is generally taken as one-fourth of the speed in miles per hour plus two pounds: at 20 miles an hour this also gives 7 lbs. per ton; and the weight of the engine and tender must be included as well as the weight of the cars.

For the resistance due to grades we must know the amount of ascent either in feet per mile or in per cent of length. The resistance per ton will be .38 times the number of feet rise per mile of track, or 20 times the per cent of rise when stated as a percentage, that is, 20 pounds per ton for a 1 per cent grade. Curvature has a resistance of about .7 pounds per ton per degree of curvature, but it is probable that locomotives with long rigid wheel-base about double these figures.

It requires a great deal of power to accellerate a train, that is to bring it to a given speed from rest, or from a lower speed to a higher speed. Including the rotative inertia of the wheels and axles it is necessary to exert a force in pounds per ton equivalent to 70 times the square of the speed in miles per hour divided by the distance in feet in which the accelleration is to be effected, or 95.6 times the speed in miles per hour divided by the time in seconds, if time instead of distance be considered in the calculations. If the speed is to be increased from a lower one to a higher one then in the first case we should substitute the difference between the squares of the speeds and in the latter case the difference between the lower and higher speeds. In all cases the weight of the engine and tender must be included in making up the total resistance and this total must not exceed the tractive force as determined above.

The relative weight of cars and their loads also enters into the problem. It has been found by experiment that empty cars on a level track require a much greater force per ton to haul them than when heavily loaded, this being due no doubt to the fact that the wheel and axle friction has a smaller total weight into which to be divided. As a matter of fact it was necessary to allow about 30 per cent on a level for empty cars over a similar total tonnage of loaded cars. The resistance of a train can be considered as depending both upon the number of cars and the total weight and it has been suggested that this total resistance might be taken as 3.5 times the weight of the train in tons of 2,000 lbs. plus 50 times the number of cars in the train, the resistance so figured being in pounds at the tender drawbar, and on a straight level track with speeds not exceeding 10 miles an hour. From this rule we find that a car weighing 16 2/3 tons would have a resistance of 6.5 lbs. per ton, one of 33 1/3 tons a resistance of 5 lbs. per ton and one of 50 tons total weight a resistance of only 4.5 lbs. per ton.

Thus we see that the advent of 50 ton cars has the effect of reducing the train resistance not only by their lighter weight per unit of capacity but also by the fact that heavier loads are carried on an equal number of wheels. Ten years ago there were few cars of greater capacity than 30 tons, and now 50 tons of coal and ore are quite common. These high capacity cars generally have steel frames and weigh little more empty than the 30 ton cars with wooden frames of previous years. The draft gear is of course very much more heavily strained than formerly, as the first car in the train must take the total pull of the one or more locomotives at the head of the train; this has led to the introduction of friction draft gears instead of entire dependence upon springs. The steel sills are much better able to stand the heavy pulling and buffing strains than the old time wooden sills and while the cost is considerably greater (about $200 or $300 per car) the evidence at this time indicates a much longer life and usefulness for the steel cars and a decreased cost of repairs.

G. R. Henderson,
Author 'Locomotive Operation.'

Railway Heavy Passenger Trains. Like everything else in railroading the heavy passenger train of to-day is a creature of evolution. Heavy long-distance trains were an impossibility before the development of safety appliances and the inventions of Westinghouse and Pullman and before the consolidation of connecting lines had proceeded to a sufficient extent to permit of the passage of trains for many hundreds of miles over tracks under one management. Friendly co-operation between connecting lines, indeed, is the distinguishing feature of these famous trains.

The «Flying Yankee,» one of the first of these trains, beginning service in 1884 between Saint John and Boston, is still in service. It consists regularly of ten cars, all vestibuled, and uses the tracks of three railroad companies to accomplish its daily journey. The Cleveland, Cincinnati, Chicago and St. Louis, better known as the Big Four Route, sends it Florida Special from Chicago and Cleveland to Saint Augustine, and claims patronage on the ground that the traveler is but one night out from Chicago. This train is taken up by the Queen and Crescent Route at Cincinnati, the Southern Railway at Chattanooga, and the Florida East Coast Railway at Jacksonville. Another heavy long-distance train is the Washington and Southwestern Limited of the Southern Railway. It has been operated in daily service for fifteen years. Using the Pennsylvania Railroad from New York to Washington, the Southern Railway takes the train in charge to Atlanta over its own tracks. Here the Atlanta and West Point and the Western Railway of Alabama are called into service for the journey to Montgomery, and from this point to its final stopping place—New Orleans—the Louisville and Nashville is used. The equipment is exclusively of high grade, heavy Pullman standard, including club and smoking cars, drawing-room sleeping cars and observation-library cars, besides a heavy dining car.

A notable instance of co-operation in through service of heavy trains is furnished by the Missouri Pacific, the Iron Mountain, the Texas and Pacific, the International and Great Northern, and the National Lines of Mexico, in the recent establishment of the Mexico-Saint Louis Special. This train leaves Saint Louis semi-weekly on Tuesdays and Fridays, and occupies fifty-five hours in the journey to the City of Mexico. No higher grade of service has ever been attained between this country and Mexico than is that of this solid vestibuled train. See RAILWAY SYSTEMS and RAILWAY TRAFFIC.

Railway Hospitals, in the United States. When the question of hospital relief of the railway employees of this country is compared with other countries, particularly the European, the investigator will be surprised and shocked to find how inadequate and inferior are the provisions made in the United States, in comparison to those in Russia, Germany, France, England and other countries. W. H. Ballou writing on this subject, says:

> It is to be regretted that the story of the injured American railway employee is not wholly flattering to this nation, and that to tell it truthfully, even with its hopeful features, followed by the story of the Russian railway employee, must necessarily redound to the glory of Russia. Incapacitate a Russian railroad man, however high or humble, and he and his family become the wards of the government so long as they live. The American railway employee often has only his brotherhood or labor organization on which he can rely somewhat in case of death or accident. Apparently there is nothing for his family except his small savings, if any, and his small share of a brotherhood or association insurance fund, excepting on a few lines. In case of his death, his family must practically become their own bread winners. If he is maimed, he is probably taken to the nearest public hospital, if in a populous district, or he may be thrown on the liberality of the nearest farm-house and country doctor. If incapacitated for life he often becomes an object of charity; or if arrangements can be made for his care at a very small cost his brotherhood and the several organizations to which he belongs assess themselves for his maintenance. What to do with incapacitated employees has ever been a problem for the railway man.

It cannot be stated that this subject has not received thorough investigation. No subject in connection with railway management has been any more thoroughly and intellectually studied. The conditions existing in this country are so radically different from those existing in European countries, as to make it a problem in political economy far-reaching and excessively difficult of solution. Charles Francis Adams, Dr. W. T. Bernard, W. T. Kirkman, Samuel R. Barry, K. H. Wade, R. F. Smith, and a host of others, have studied this question and written extensively. It is to be deplored that neither productive co-operation, nor profit-sharing plans have demonstrated their practicability and magnificent effects in influencing industrial interests. It is reasonable to believe that all earnest, sensible men, be they the chief executives of large industries or not, would hail with pleasure any solution to the labor question.

It will be manifest to the most casual investigator that the advancement in relief measures in this country is slow and halting, but while various forms of relief measures are far behind the European countries, it is an undoubted fact that no form of labor as a mass is as highly paid as railway labor is in this country; the wages paid to the railway employee would be sumptuous pay for many professional men in Europe. The Interstate Commerce Commission states that 60 out of 350 railway companies have an insurance or guaranty fund, or hospital fund, or relief association affording aid in various degrees to employees, or both co-operating on some mutual plan, 13 companies make distinct provision for superannuated employees when disabled by accident; 125 companies give preference to employment for service for which they are qualified, or provide in divers ways and degrees during disability at the companies' expense; 225 do not.

The hospital departments differ from relief associations in the fact that the relief departments are essentially insurance companies insuring the sick and injured employees for loss of time in sickness, and injury and death benefits to family. The rate of assessments in relief associations ranges from 75 cents to $3.75 a month. We will name only the best form of relief associations, as being those of the Pennsylvania Railroad Company, the Baltimore & Ohio, the Chicago, Burlington & Quincy, and the Delaware, Lackawanna & Western, while the Northern Pacific Company has a mixed hospital department and relief association. The Pennsylvania Railroad Relief Association and the Baltimore & Ohio have had pension features operative. Hospital departments differ from relief associations in the fact that an employee signing the application for membership in a relief association signs away his rights as a litigant for injuries received, and accepts in lieu thereof sick, injury, pension and death benefits. Membership in hospital departments have no connection with the future litigation of an injured employee. The average rate of assessments in hospital departments are 25c and 50c monthly. For the assessment the hospital department gives treatment for all diseases (except those arising from vicious acts), and for all injuries. The monthly assessment is contributed for the purpose of sustaining the hospital department. All compensations for injuries received are settled for by the companies according to legal merit in each case through claim and legal departments.

RAILWAY HOSPITALS

Hospital departments upon railroads in the United States were established as a matter of necessity and economy, as railways were built and extended over trackless plains or among tortuous passes and cañons of mountain ranges, in thinly peopled regions, and it was at times utterly impossible to obtain medical relief. It soon became demonstrated that the indiscriminate employment of medical men whose sympathy and warped judgment when treating either injured railway passengers or employees made prejudiced and unjust witnesses in case of litigation, and thus became extravagant factors. Again, it was shown that a trained corps of experienced surgeons when employed by the railway companies were enabled (owing to extended experience and consequent education), to be more competent to obtain better results in the treatment of these (railway) injuries than the inexperienced and imperfectly trained. The first hospital department organized upon any railway in the United States possessing the characteristics of hospital department as now organized, was developed by the late Col. A. N. Towne, second vice-president and general manager of the Southern Pacific Railway. This hospital department was organized in California in 1868, and was at first maintained by voluntary assessments, but this form of assessment not being self-sustaining, the assessments were made obligatory upon each and every employee of the Southern Pacific. It was not until 11 years after that the Missouri Pacific Company organized its hospital department, shortly after the late Jay Gould began the formation of the Missouri Pacific system. As each new road was added the hospital department extended over it. The Missouri Pacific system then included the Missouri Pacific Company and branches, the Missouri, Kansas & Texas, the Saint Louis, Iron Mountain & Southern, the Texas & Pacific, the International & Great Northern, the Wabash East and the Wabash West. Afterward the Atchison, Topeka & Santa Fé, the Gulf, Colorado & Santa Fé of Texas were started, and at the present time there are 17 companies having organized hospital departments, treating annually over 268,000 patients.

In the formation of hospital departments, the circular issued by the management of the railway constitutes the source and directions for collecting deductions to constitute a hospital fund. It is not necessary to give the rules in full, but the following will answer:

1. On wages earned of $50.00 and over per month a deduction of 50 cents shall be made. On wages earned of under $50.00, a deduction of 25 cents shall be made.
2. No deduction will be made when the amount earned is less than $1.35 in any one month.
3. Any employee who may be taken sick shall be entitled to admission to the hospital upon presentation of certificate signed by his (or her) foreman, approved by the head of that department of the company's service.
4. Patients received at the hospitals and emergency stations will be provided by the institution with everything necessary to their careful and comfortable treatment, so long as they obey the rules established for their protection and require the professional service of a surgeon or physician.
5. Any employee receiving a certificate of disability, signed and approved as above, will be entitled to receive from the head of his department a pass to the hospital from any point on the line.

Local surgeons are appointed along the line ranging from 30 to 50 miles apart. All local surgeons are under contract, and the fee bill for services is contained in the contract. The following explains the manner in which accidents are cared for:

INSTRUCTIONS TO EMPLOYEES AND OTHERS FOR THEIR GUIDANCE IN CASES OF ACCIDENT RESULTING IN PERSONAL INJURY.

1. All cases of accident where an employee or other person is injured, notify at once the chief surgeon of the same, and place the injured person in the care of the nearest division surgeon or local surgeon as soon as possible.
2. When the injured person is able to be moved take or send him to the nearest division surgeon or local surgeon in the direction in which the first train is going, notify the local surgeon by wire of his coming and the character of his injury.
3. In case the injured party cannot be moved, place him in the care of the nearest local agent, who will take charge of him, and notify at once the nearest divison or local surgeon.
4. No surgical operation shall be performed until the arrival of the division surgeon or local surgeon, unless it may be required for the immediate satety of the patient.
5. In cases of accident, when a number of persons are injured, procure at once the services of competent surgeons in the immediate vicinity and give every attention and care to the wants of the injured. Notify division or local surgeon in each direction and the chief officers of the road by wire, giving particulars, number injured, and what is required for their relief.
6. Tramps, children, and other persons not employees, injured by their own carelessness, in jumping on or off trains, must be sent to their homes, or placed in charge of local relief authorities.
7. In case of injury resulting in death of party, notify coroner at once, and await the direction of the chief surgeon as regards disposition of remains.
8. Stretchers for the convenience of injured and sick are to be found on all train baggage cars, and at all points where local surgeons are stationed.

INSTRUCTIONS IN CASE OF SICK EMPLOYEES.

1. Sick employees desiring hospital benefits must procure from their foreman certificates (furnished them for this purpose) which when presented at either of the above-mentioned hospitals, will entitle them to admission or treatment, as they may desire, except chronic disease and those arising from vicious acts.
2. Employees desiring medicine can apply for the same at hospital and emergency stations. These applications for medicine must be signed by the foreman, otherwise they will not receive attention.
3. Passes will be supplied all employees by heads of departments for transportation to the various hospitals. In case of emergency when delay would arise in procuring a pass, notify chief surgeon by wire, and transportation will be arranged at once.
4. Applications for medicines should be addressed to chief surgeon.

The hospital fund being now established, chief surgeon, division surgeons and local surgeons appointed, local surgeons' reports furnished and various forms needed supplied. In the start of any hospital department the railway company supplies the hospital; besides supplying transportation to and from the hospital or hospitals, and emergency stations. The company collects and audits and has general supervision of the hospital fund. It assumes all the responsibility in case of an inadequacy of the fund to meet all obligations brought against the hospital department. Besides having division and local surgeons in hospital department, each hospital in the department has a competent corps of surgeons, from two to five hospital internes, all necessary specialists, such as the oculist, the aurist, throat and lung specialist, the dermatologist, neurologist, and the bacteriologist. The specialists employed upon the hospital staff are generally medical men of high reputation. Prescriptions are filled and sent out to any employee making proper application. Trusses, elastic bandages, various minor prothetic agents, are sent when requested. Large systems like the

Atchison, Topeka & Santa Fé, the Southern Pacific, and the Missouri Pacific, having more than one hospital situated in different regions of country, are enabled to make an interchange of patients where climate may be beneficial. The consumptives sent to climates having favorable surroundings and proper altitude. Employees suffering from catarrhal and rheumatic troubles are sent to hospitals built in the warm regions of the South. This interchange of patients cost the sick railway employee nothing but the small sum of money used in buying sustenance from one point to another. Where prominent watering places such as Hot Springs are on the line of road, local surgeons are stationed for the purpose of treating sick employees.

The benefits of the hospital department having broadened out in every direction for the benefit of the sick and injured employee, the most casual investigation will show that these departments are all well patronized. In the matter of sanitation and hygiene, these departments have been very efficient and useful, issuing from time to time circulars for the guidance of the employee during the prevalence of epidemic or endemic trouble; also in investigation of the sanitary condition of depots, shops, and section houses, and doubtful water supply. At this juncture a description of the manner in which the larger hospital departments and associations are administered, there being differences concerning the benefits obtained by the employee and the form of government controlling the collected hospital or association fund.

The Southern Pacific Hospital Department has one general hospital in San Francisco, Cal., costing $160,000, besides having six division hospitals, and nine emergency stations. These hospitals and emergency stations in 1903 treated 58,220 patients; 3,395 were in-patients, the balance were out-patients. This department gives the following benefits: hospital treatment, medical and surgical outside of hospitals, medical and surgical dressings, artificial limbs and appliances, accommodations at railway and contract hospitals for dependent members' families. The government of the hospital fund is by the general officers and chief surgeon of the Southern Pacific Company.

The Missouri Pacific Hospital Department is governed by the vice-president, general manager and chief surgeon, and has one general hospital in Saint Louis, costing $110,000, one division hospital, 12 emergency stations, with six contract hospitals. It has the following benefits: medical and surgical treatment at hospitals and emergency stations; supplies surgical dressings, prescriptions sent out on road, also supplies mechanical appliances, trusses, artificial eyes, and various minor prothetic agents; carries out interchange of patients from one hospital to another, requiring climatic treatment for sick employees, issues when needed to the employee hygienic and sanitary circulars, and supplying coffin and shroud for dead employees. Total number of patients treated 42,084.—In-patients, 8,615; out-patients, 33,469.

The Atchison, Topeka & Santa Fé Hospital Association is governed by the Atchison, Topeka & Santa Fé employees, electing annually a board of control and the chief surgeon. This association has five new and modern hospitals; the Topeka hospital costing nearly $100,000. All of these hospitals are owned by the hospital association. There are two emergency stations at Denver and Chicago. It supplies surgical dressings, artificial limbs, trusses and mechanical appliances, medical treatment extended to employees along the line of railway and hospital benefits at all of the hospitals; likewise, interchange of patients for troubles benefited by climate. Total number of patients treated by this association: surgical cases, 4,898; medical cases, 34,273. Total from all sources, 39,171.

The Northern Pacific Beneficial Association of the Northern Pacific Company, is governed by Hospital board elected annually, and has two general hospitals, two division hospitals, and six emergency stations. It has essentially the same benefits as the Atchison, Topeka & Santa Fé Hospital Association and the Southern Pacific. It treated 33,375 patients during 1903.

The Wabash Employee Hospital Association of the Wabash Railroad Company, has three division hospitals and 11 emergency stations. The benefits are the same as the Missouri Pacific Hospital Department. It treated in 1903, 3,151 surgical cases, 22,865 medical cases; total, 26,016.

The Saint Louis & San Francisco Hospital Association, governed by Employees' Hospital Association, has one general hospital and 15 emergency stations. In 1903 it treated 11,573 medical patients, 4,852 surgical patients. Total treated, 16,425.

The Denver & Rio Grande Medical Department, governed by the Board of Employees. The benefits are the same as Missouri Pacific Railway Hospital Department. Has one general hospital, 12 emergency hospitals. It treated in 1903, from all sources, 15,581 cases.

The Saint Louis Southwestern Medical Department is governed by general officers and chief surgeon, and has two hospitals. The benefits are the same as the D. & R. G. It treated in 1903, from all sources, 13,809 patients.

The Missouri, Kansas & Texas Hospital Department is governed by the general officers and the chief surgeon, and has one general hospital and nine emergency hospitals. The benefits are the same as the Missouri Pacific Hospital Department. Treated in 1903, from all sources, 9,876 patients.

The Texas Midland Hospital Department, International & Great Northern Hospital Department, Gulf, Colorado & Santa Fé Hospital Association, and the Chesapeake & Ohio Hospital Department have eight hospitals, treating annually nearly 19,726 patients. The benefits are the same as Saint Louis & Southwestern. Hospital departments upon railways enable the employee belonging to these departments to obtain compensation for personal injuries and permanent disability far in excess of what the employee could possibly obtain when working upon a railway not having hospital department. Labor organizations predominate upon Western systems. Each branch of service has its own labor organization. Thus the engineer belongs to the Brotherhood of Locomotive Engineers; the conductor to the Order of Railway Conductors; the fireman to the Brotherhood of Locomotive Firemen; the brakeman and switchman belong to the Brotherhood of Railway Trainmen, etc. Each of these orders has its own insurance features, the orders aiming to become thoroughly protective, sustaining their members when in enforced idleness, ensures them against permanent disability, and members' families by payment of death benefits. Suppose that a locomotive engineer has been permanently disabled, he at the time of his permanent disability is employed upon a railway having a completely equipped hospital department. He is treated free of charge from a year to a year and a half and more, that is, until well. During the time the employee is disabled he is supplied with all necessary medical and surgical treatment, for which he has paid 50 cents a month, or $6 a year, getting a return for this several hundred fold of that which he has contributed. Had this employee been compelled to pay for treatment, it can be readily seen what doctor, board, nurse and other bills would amount to. Perhaps this same workman has not accumulated in the interim of his labor enough means to stand the expense, still he receives this treatment in virtue of the fact that he has paid his assessment to the Hospital fund, which justly entitles him to the treatment received, and is in no sense dependent upon charity. Again, let it be understood, that this same injured man is a member of the relief feature of the association of the Brotherhood of Locomotive Engineers. He gets from this source from $1,500 to $4,500 for permanent disability. In addition to this there is left to him what he may get from the railway company for the settlement of his claim. If he has been provident, as a good many are, he may hold one or more policies from one of the regular accident insurance companies. The money he receives from his order enables him to take care of his family while he is laid up in process of treatment. It is not a remarkably infrequent thing for a permanently disabled employee to obtain from $2,000 to $10,000, and in addition thereto receive from the company employment such as he can do in his crippled condition. It will thus be seen that many seemingly harsh emergencies are successfully met, accorded the best of medical and surgical treatment, supplied with every element required, obtains means to support his family while not earning, and afterward frequently placed in a position where he is still competent to become a bread-winner, though in a disabled condition. In England many employees are contented with $500 for permanent disability. With organized labor and a hospital department it is certainly in many instances a most perfect safeguard of the interests of the employee, not only immediate, but future.

It has been demonstrated that while the surgery of railways may in many respects resemble other violent forms of surgery still an extended experience is required in order to be enabled to accomplish the best results, so that it can be readily seen that the surgery of the present demands certain conditions which cannot be readily obtained outside of a hospital. So that, if the result is to be considered, whatever hardship may be imagined as far as treatment at a hospital is concerned, its benefits are worthy of the sacrifice. Secondly, owing to the excessive breadth of medicine, owing to the fact of its constant improvement, it is an utter impossibility for one man even to have a meagre knowledge of the entire field of medicine. Specialism has demonstrated that competency only comes from study and experience, and the results obtained by specialism have been marked and pronounced. Hence, in well regulated hospital departments every necessary specialty is employed, the oculist, the aurist, the dermatologist, the throat and lung specialist, the neurologist, so that for the $3 and $6 a year the employee has the advantage of consulting and receiving treatment from all these various forms of specialties, without any additional expense. Surely this is broad enough when the small sum is considered, namely the $3 and $6 per year paid in assessments. Again, they enable the employee to be removed from unhealthy regions to more healthy ones. The management furnishes passes to and from any part of the line as deemed best by the surgeons in charge of its hospitals and emergency stations, and employees are thus brought to hospitals from malarial portions of the country to nonmalarial, and it is possible for the humblest employee to change from bad to more healthy and salubrious climes. The hospital department is thus enabled to effect cures by the fact of this change which otherwise could not be accomplished; besides they are enabled to send the consumptive to climes better fitted for his treatment and care which a lack of means on the part of the employee would oftentimes debar. See HOSPITALS. DR. W. B. OUTTEN,

Chief Surgeon Missouri Pacific Railway Company.

Railway Interchange Car-Service. Whenever traffic demands it, and physical and political connections allow it, cars are interchanged between railways. The arrangements under which these interchanges are made vary, but they are always intended in some sort to compensate the car owner for the use of his property and usually to secure its return. Some of these arrangements, therefore, are based upon the distance traveled by the car upon foreign rails, others upon the time the car is away from home, while others yet are «mixed systems» combining the bases of distance and time. It is to be noticed that where the interchanges are most general the arrangements are the simplest. Thus, in Europe where mixed systems prevail the interchange of freight cars is not so general as in North America where a simple system based on time is in effect. Again, in North America the interchange of passenger cars, which involves a prior agreement as to whether the basis of compensation shall be time or distance, is not so general as the interchange of freight cars, which is covered by this general and simple agreement. The agreements and arrangements covering the interchange of cars are made in some cases between two railways, in others by associations of railways, and in other cases by governments. Thus, on the continent of Europe interchanges are arranged by the government involved, in England by the Railroad Clearing House and in North America by the American Railway Association.

In Europe and Asia it is quite general to make a certain charge per mile for the use of foreign cars on the understanding that a certain time will be allowed for a journey of a certain length. If the car is delayed beyond the time allowed, a demurrage charge is imposed besides the mileage. The various systems in vogue are of a certain complication involving a separate calculation for each car, and in some cases more than one calculation. In America, on the other hand, the tendency has always been toward simplicity, even when this sacrificed more essential conditions. In the interchange of passenger cars the interest of the car owner has always been conserved, but in the interchange of freight cars, until a comparatively recent date, the interests of the car owner were sacrificed in the interest of a faulty simplicity. Since the middle of 1892, however, a marked improvement has been made, and the car owner is now sure of a certain compensation for every day his car is on a foreign railway.

The value and scarcity of passenger cars has always made railways conservative in their interchange. When two or more lines regularly interchange passenger cars in America in «through service» it has been quite general to equalize the mileage so far as may be by manipulation of equipment, so that the mileage balance could be made as small as possible, and this mileage balance has generally been settled on the basis recommended by the American Railway Association, which includes in its membership all of the prominent railways of North America. These mileage rates are as follows:

Coaches, etc.	Three cents per mile.
Baggage cars, etc.	One one-half cents per mile.

In cases where passenger cars are loaned temporarily it has been more usual to apply the «Per Diem» rates recommended by the same body, namely:

Coaches, etc.	$5 per day.
Baggage cars, etc.	$3 per day.

With freight cars the case is different. The American Railway Association having adopted a set of «Per Diem Rules Governing Settlement for the Use of Freight Cars,» in April, 1902, the railways of North America, with few and unimportant exceptions, signed an agreement that they would abide by these rules for the space of one year and thereafter upon three months' notice. This agreement has now been in effect nearly two years with slight amendments in the rules, and there is every indication that the arrangement will be a permanent one. The claim is made, with some show of justice, that this agreement of 551 railways, representing a capital of over $13,000,000,000, if not the most important, is certainly the most far-reaching agreement ever signed. The rules covered by this agreement provide for a uniform payment of 20 cents a day for each car. If any road holds a car more than 30 days, the owner upon due notice, can increase this rate to a dollar a day, thus putting into effect what is called the penalty rate. There are rules also which provide a certain relief for belt lines, rules providing for the necessary accounting features, for embargoes and for the arbitrating of differences.

Up to 1902 the arrangements for the settlement of freight car interchange in North America were in a very peculiar condition. When the first American railways were built it was not supposed that they would interchange their own cars. Indeed, it was generally thought that all cars would be provided by the shippers. The first cars interchanged between railways were generally not railway cars but cars belonging to «fast freight lines,» some of which were owned by individuals and others by associations of railways. It was quite general to divide the through rates charged by these fast freight lines on a mileage basis and it was natural that the expense for cars should be divided on the same basis. The first rate generally in effect was one cent per mile, and this rate, which was primarily applicable to private line cars only, was gradually extended to such railway cars as were interchanged, the car resources of the fast freight lines proving inadequate to supply cars for the traffic offering. The first of these railway cars interchanged appear to have been sent away from home without any definite understanding either as to compensation or as to reports of movements; but, as above, the rate of one cent per mile (which was afterward reduced to three fourth of a cent and later to six mills) came into general effect, and it was arranged by the Car Accountants' Association, which represented most of the railways of the country, that a «junction report» should be sent to the owner of each car whenever it was interchanged between foreign railroads. By entering up these junction reports in their car records each railway was able to locate its cars and to trace for them either by letter or by «Car Tracers» or «Lost Car Agents,» who were largely employed to secure the return of cars. For, it should be noted that this mileage system, which had been adopted for the compensation of car owners, did nothing to secure the return of cars to their owners. Indeed, it was cheaper to hold a car indefinitely than to return it, as the actual movement of a car in the direction of home cost 75 or 60 cents for every hundred miles it moved, while it cost nothing to keep it standing. Another difficulty lay in the fact that there was no effective check on the accounts rendered by each railway for the use of the cars of others, and there was some suspicion that certain mileage accounts were cut. The vices of this system were early recognized by some of the railways and in the year 1876 the Union Pacific and the Chicago, Burlington & Quincy arranged to cover their own joint interchange by a per diem payment at the rate of 50 cents per car per day. This arrangement continued in effect for a couple of years with the result that the movement of the cars covered by this arrangement was greatly expedited. There was no general agreement, however, with other railways to put this arrangement into effect and it was, therefore, discontinued. The per diem system was later called to the attention of the Car Accountants' Association by J. T. Rigney, of the Baltimore & Ohio Railway, who in 1878 read a paper before that body urging its general adoption. Mr. Rigney's efforts were followed by W. P. Shinn, who covered the system in an admirable set of papers which did a great deal to mold the opinion of railroad men on the subject.

Although the condition became worse year after year and the delays to foreign equipment became very serious, especially at terminal points where individuals without capital were encouraged by the mileage system to undertake extensive business by using railway cars as warehouses, no steps were taken toward the mitigation of the mileage system until 1888 when it was brought before the Trunk Lines, and Albert Fink formulated a set of rules covering a mixed system, which provided for the payment of one half cent a mile and 15 cents a day for the use of cars. This plan was logical, inasmuch as the per diem rate was intended to cover the cost of depreciation and interest on investment, while the mileage rate was intended to cover repairs, but it was much more expensive in administration than the mileage rate. Unfortunately when it was adopted it was by two of the stronger lines without consultation with the rest of the country. As a result only a minority of the railways adhered to the plan and after it had been in effect for a month, there began a series of secessions of the railways which found it expensive in comparison with the mileage system. Each secession made the system more expensive to the two trunk lines which had originated the experiment and at the end of a few months the plan was definitely abandoned.

This experiment of 1888 was very expensive to some of the lines involved and the experience gained showed clearly that no experiment could succeed unless the arrangement was put into effect throughout substantially all the United States and Canada and was kept in effect until sufficient experience had been gained to warrant a change in the rules. The failure of the experiment also cast a shadow over «mixed car service systems,» and subsequent movements have usually been in the direction of a straight per diem system. During the experiment of 1888 the detail of the rules was referred to the Committee on Car Service of the American Railway Association and this body has ever since had a general charge of the matter. It had early formulated a set of «Car Service Rules» which included the practice approved by the association in regard to the interchange of passenger and freight cars, but these rules although they covered fully the interchange of passenger cars and gave many particulars as to the proper handling of freight cars have always been silent as to the compensation for the use of freight cars interchanged. Rules covering per diem payments for use of freight cars were reported to the American Railway Association on several occasions by the Committee on Car Service between 1888 and 1901, but the rules were invariably referred back to the committee or tabled. Another mixed system, originated by J. M. Daly, was also tried on seven important western railways in 1898, but it lasted only a short time.

In the year 1901, however, the question was again taken up. For over a year through a remarkable revival of prosperity and expansion of industrial enterprise, there had been a marked shortage of cars on all the railways in the producing sections of the country, and these railways saw their own cars gradually leaving them only to be delayed without recourse upon foreign lines. It was by no means unusual for a railway to see half of its freight equipment and more on foreign lines, at a time when it could not fill its orders for cars. It is an open question whether the so-called «car shortage» was really a shortage of cars, a shortage of terminal facilities, a shortage of engines, a shortage of machine shops or a shortage of mechanics, but it was evident to every car owner that his cars were too long away from home, that he was not properly paid for their use, and that the foreign roads really had no incentive to return them. At that time the rate paid per mile was six mills and the average earnings of cars on foreign lines was less than 12 cents a day. This was evidently the time for the introduction of the per diem system.

The loss to car owners in the poor movement of their cars was so evident that a group of prominent financiers commissioned J. W. Midgley to investigate and report upon the question. This gentleman's prior experience had been chiefly with the traffic and financial sides of railways, but in the investigation which he made of the subject he speedily recognized the advantages of a per diem system, which he pointed out in a series of forcible reports to the subscribers to his bureau, which were widely studied by the executive and operating officers of railways. These papers gave in great detail the history of the per diem movement and strongly urged the adoption of a per diem system, but, Mr. Midgley wisely confined his efforts to the awakening of interest in the matter and did not attempt to formulate a working plan. It was during this revival of interest in the subject that the American Railway Association met at Saint Louis in October 1901. The matter was carefully canvassed in the association and the last report of the Committee on Car Service was taken from the table and referred back with instructions to prepare a practical scheme for the introduction of the per diem system. This action was taken without opposition, as the railways which were profiting by the mileage system did not apparently realize the decided feeling on the subject and the far-reaching character of the instructions given the committee. For the next six months the Committee on Car Service was busily occupied in formulating a set of rules for the per diem system, in which they were aided by a large majority of the roads in the country. The circulars of the committee, asking for information, were answered fully and carefully and the committee in its deliberations was, therefore, guided by the views of practically all the men in the country who had experience in car service matters. At the same time the opposition began to crystallize. A per diem plan, such as had been heretofore presented, was most objectionable, first, to the belt railways, which had never paid any mileage at all; second, to all the short railways, which made a small mileage per day on foreign cars; and third, to certain private owners of cars, and especially of refrigerator and stock cars, which, for traffic reasons, were moved on fast freight trains and which made high mileage per day. Many of these private parties were also interested in railroads and it was felt their opposition might seriously complicate the adoption of the per diem system.

The first duty of the committee, was, of course, to construct a workable system, and in this they were aided greatly by the experience gained in 1888. The car accounting features of the rules as decided upon, presented, therefore, no marked innovation and have worked without friction. Prior schemes had not, however, provided for the settlement of differences of opinion in regard to the rule or any continuity of the arrangement. These points were covered by arranging for an arbitration committee and also for a per diem agreement to be signed by the railways participating. Having arranged a scheme which would be workable generally, it was necessary for the committee to provide for certain exceptional cases. This it did by arranging that the per diem should be regularly reported at the end of every month and exceptions should be covered later by a system of what they term «reclaims,» the word reclaim being adopted instead of refund, or some more usual term, in order to separate the reclaim payments from all others. It was felt that the circumstances in different parts of the country so varied that no central body could settle exactly what would be a fair reclaim for cars in switching service on belt roads, but it was decided that any reclaim that was made should be an arbitrary amount per car, so as to preserve the incentive for prompt movement. It was also provided that the per diem on cars refused at interchange points should be covered by reclaim and provision was made for special reclaim covering special circumstances.

It then remained for the committee to figure out a per diem rate which could be accepted in all parts of the country and here they were urged on one side to make the rate as low as 12½ cents a day and on the other, to make it as high as one cent per ton capacity. A compromise rate was the only one that could be generally accepted, and the committee finally advised a 20 cent rate, with the proviso that in case a car was delayed on any one line longer than 30 days, a penalty rate of $1 could be imposed in lieu of the per diem rate. The opposition of private car owners was obviated by leaving private cars entirely out of the question and providing that per diem rules covered railway cars only.

With this scheme worked out the committee reported to the American Railway Association at its meeting in New York in April 1902, where the rules were debated in full and the liveliest opposition encountered on the part of advocates of mileage, of low rates, and of high rates. The rules, however, were adopted by the association by a large majority and it was agreed to put the plan into effect on 1 July 1902, provided that the agreement was signed by a majority of the whole membership of the association and provided that that majority owned 66 per cent of the cars owned by all the members of the association. The agreement was promptly circulated among the railways of the country at large and the secretary of the association was able to announce in a comparatively short time that the agreement had been signed by the desired number of members. There was some opposition on the part of a comparatively small number of roads in the East who attempted to make an exception of cars loaded with cotton, but this was promptly settled by the withdrawal by the per diem railways of all through rates on cotton to the territory in question, a stroke which led to an immediate adhesion to the per diem plan of practically all dissenters.

This plan has now been in effect for about two years and while there are still certain difficulties in its administration there seems to be no prospect of a departure from the general per diem principle. Indeed, there is a strong movement in the direction of applying the principle to private cars. It was anticipated when these rules went into effect that there would be constant litigation under them, but the fact that there have been only 16 cases decided by the Arbitration Committee shows that the rules are generally satisfactory. To be sure, a number of the larger car owners are still pressing for a higher rate and an abolition of the penalty which will possibly be arranged in time, and a number of industrial railways are endeavoring to enter the scheme because of the very liberal reclaim allowed on switched cars. Again, there is a disposition shown on the part of some of the larger systems to divide themselves for car accounting purposes in order to avoid the penalty rate, but none of the difficulties involved appear to be radical or to approach in magnitude the radical difficulties of the past mileage systems. It is thought, therefore, by a careful revision of the rules from time to time the per diem system can be maintained and its efficiency improved.

ARTHUR HALE,
Gen. Supt. Transportation Baltimore & Ohio Railroad Co.

Railway, Intercontinental, or **Pan-American,** a proposed railway system extending from the United States through Mexico and the Central American states to Panama, and thence southward to Brazil. The Intercontinental Railroad Commission was organized in Washington in 1889 to study the feasibility of extending a trunk railway from our country to Buenos Ayres. The report of the commission on its studies and its surveys for the best route was published in 1899. The proposed all-rail route to Buenos Ayres will be 10,228 miles long by the route which the surveyors selected. In 1900 the existing lines that might be used as a part of the trunk railway were about 4,772 miles in length, leaving 5,456 miles to be constructed. Since that time the Latin-American countries have built 656 miles of track along the international route, reducing the portion yet to be constructed to 4,800 miles. Only about an eighth of the mileage has been built since 1900, but this has been done in the natural course of railway building without any reference to the Intercontinental project. The estimated cost of construction for the 4,800 miles is placed at $150,000,000. This is based on an average of 50 cents gold as the daily wage labor, with an efficiency of 75 per cent as compared with similar labor in the United States.

Railway Labor Organizations, labor unions formed by the employees of railways to advance their interests and promote their social, moral, and intellectual welfare. The larger and more typical railway labor organizations are distinguished for their generally conservative attitude, their large mutual benefit and insurance funds, and their organization of grievance committees for arranging differences between their members and employers, and avoiding strikes. As a rule they maintain pleasant relations with employers, and have been instrumental in obtaining increased wages and general improvement in the condition of railway labor. The five most prominent organizations are the Grand International Brotherhood of Locomotive Engineers, the Order of Railroad Conductors, the Brotherhood of Locomotive Firemen, the Brotherhood of Railway Trainmen, and the Order of Railroad Telegraphers. These five have the same general form of organization with the supreme power in the central representative body called the Grand Lodge or Grand Division, meeting in convention every two years, and the executive power vested in a chief executive (Grand Master or Grand President) and an executive board. Their subordinate divisions include locals and section divisions, the latter made up of the employees of one railway line or system. Their provisions for dealing with grievances against employers are as follows: Any member or members having a grievance against an employer are to report the same to their local organization, which, in case the majority vote to sustain the grievance, shall refer it to a local grievance committee. This committee is to deal with the local management, and should no satisfactory settlement be made, refer the grievance to the General Grievance Committee of the section, who shall confer with the general manager of the railway system. Then, if no adjustment be made, the matter is to be referred to the chief executive of the union who shall make another attempt to adjust the matter with the employers, and, if he fail, he and the General Committee shall have power to sanction a strike, provided a strike is agreed upon by two thirds of the members involved. In some cases a board of adjustment is formed by the chairmen of three or more general committees, in which case the matter is to be referred to this board before going to the chief executive. It will be seen that this arrangement makes a strike difficult to bring about, and prevents strikes for trivial causes, yet all of these unions have established large protective or strike funds for the benefit of members when on strike. Another feature of these organizations is the Legislative Board, organized in each State by representatives from each local for the consideration of questions of legislation affecting their unions; and these boards have power to appoint one or two members to remain at the State capital for securing desired legislation.

The Five Larger Brotherhoods.—(1) The Brotherhood of Locomotive Engineers was organized in 1863. The locals have sick and death benefit funds, and the Brotherhood has a fund for pensioning widows and children of the deceased. The insurance is under the management of an affiliated organization known as the Locomotive Engineers Mutual Life and Accident Insurance Association. In 1903 the brotherhood numbered 42,000 members in 596 locals. The official journal is the 'Journal of the Brotherhood of Locomotive Engineers,' published monthly. It ranks among the most important and influential labor organizations of the United States and is noted for its conservatism. (2) The Order of Railway Conductors was organized in 1868 as the Conductors' Brotherhood, was threatened with serious difficulty on account of its prohibition of strikes, and a rival union started which had a «protective» policy, the Order adopted the same policy, established its «protective» fund, and the two organizations were united under the present name. It has a mutual benefit fund, and the strike fund provides for the payment of $50 per month to strikers for not over three months. The official journal is the 'Railway Conductor,' published monthly. In 1904 the membership was 32,000 in 454 locals. (3) The Brotherhood of Locomotive Firemen was organized in 1873, was involved in the great strike of 1877 and seriously crippled; for a time it adopted the policy of «ignoring» strikes, but in 1885 returned to its original policy and methods in dealing with strikes; and a few years later conducted a large strike on the Chicago, Burlington & Quincy Railroad. Strikers are paid $25 per month for three months or less. The official journal is the 'Locomotive Firemen's Magazine.' The membership in 1904 was 51,356 in 656 locals. (4) The Brotherhood of Railroad Trainmen was organized in September 1883, and admits to membership conductors, baggagemen, yardmasters, and switchmen beside trainmen. They have a sick and death benefit fund, and a strike fund, providing for a payment of $35 per month to strikers for three months or less. In 1904 it had 68,158 members in 699 locals; its official organ is the 'Railroad Trainmen's Journal.' (5) The Order of Railroad Telegraphers was organized in 1886; its membership includes telegraphers, line repairers, levermen, and interlockers. Its mutual benefit fund was established in 1898; it has never held quite the same position of importance as the other four brotherhoods, as at the first it grew more slowly because the telegraphers are scattered, and it is difficult to get any number together, but since 1900 has grown rapidly. In 1903 it numbered 30,000; its official journal is the 'Railroad Telegrapher.'

The Union of All Railway Employees.—Though these brotherhoods have much in common in organization and purpose there has been rivalry and discord among them, which has proved decidedly detrimental to their best interests. In 1895 an alliance between the five brotherhoods was formed, providing for the formation of a Federated Board of Adjustment for the consideration of grievances and management of strikes. A more centralized Federation was organized in 1898, but dissolved in 1900, leaving the agreement of 1895 in force. The first attempt to form a union which should unite in one organization all classes of railway employees was the American Railway Union, organized in the early part of 1893 by Eugene Victor Debs. This union lacked the complicated organization of the older brotherhoods, was radical and aggressive, and met with bitter opposition from the older unions. It drew away some of their membership and grew rapidly; before the close of the year it conducted successfully a strike against the Great Northern Railroad. In 1894 it inaugurated a sympathetic strike in behalf of the Pullman Car Company employees, was defeated, and shortly afterward the organization dissolved. A later attempt to unite all railway employees is the United Brotherhood of Railway Employees, organized in January 1901. It resembles the older brotherhoods in its organization and its mutual benefit department, but differs from them in its opposition to separate trade organization, and in its radical policy, being affiliated with the American Labor Union, which is avowedly socialistic. The chief strength of this Brotherhood is in the Western States.

Lesser Organizations.—Of the smaller organizations those which closely resemble the five larger brotherhoods in organization are: (1) The International Brotherhood of Maintenance-of-Way Employees, organized in 1887 as the Brotherhood of Railway Trackmen; its membership includes those employed in track, bridge, and building, water supply and fuel departments, and signal and interlocking service; it has a mutual benefit department, and the same provisions for preventing strikes and dealing with grievances as the other brotherhoods; the official journal is the 'Advance Advocate'; the membership in 1903 was over 10,000. (2) The Switchmen's Union of North America, organized in 1894, admits to membership those engaged in making up and disposing of trains. It has a beneficiary department, membership in which is compulsory for those physically sound. The organization is the same as in the other brotherhoods. The membership in 1904 was 23,000; this is less than it would otherwise be because of the fact that the Brotherhood of Railroad Trainmen, an older and more powerful organization, also admits switchmen. The official organ is the 'Journal of the Switchmen's Union.' (3) The Brotherhood of Railway Carmen, organized in 1900 by a consolidation of the Brotherhood Car Repairers of North America and the Carmen's Mutual Aid Association. Its membership consists of those who are employed in oiling, repairing, inspecting, and cleaning cars; it is a comparatively unimportant organization. (4) The National Railways Clerks' Association, organized in 1901, had in 1903 a membership of 4,000 in 35 locals; it publishes the 'Official Journal of the N. R. C. A.' (5) The International Association of Car Workers, organized in 1901, includes in its membership those employed in the construction and maintenance of all cars; it has no benefit department, but the arrangement for dealing with grievances and strikes by local and general grievance committees; its declaration of principles is conservative, including opposition to prison contract labor, and a declaration in favor of reduction of hours of work, and compulsory education. Its official journal is the 'Car Worker'; its membership in 1903 was 20,000. Of these organizations the Brotherhood of Maintenance-of-Way Employees and the International Association of Car Workers are affiliated with the American Federation of Labor (in 1904).

There is also affiliated with the Federation another railway clerks' organization known as the International Association of Railway Clerks, organized in April 1903. Its organization differs from that of the railway brotherhoods; it has annual instead of biennial conventions, no benefit department, and no system of grievance committees; a strike, however, must be approved by the district council or international executive board.

Railway Locomotive Repairs. The average life of a locomotive between the times of receiving general repairs to flues and machinery depends chiefly on the condition of the track over which the engine works, the number of tons of freight which the engine is required to haul, and the kind of water used in the boiler. If the road pass through mountainous regions and the track has many curves, the wear on the tires and machinery is exceedingly rapid and the life of the engine will be but a few months; or if the road pass through hard water districts where the water contains much solid matter, such as lime and other ingredients, the incrustation of these substances on the flues will soon render the engine unfit for further service on account of leaky flues and failures for steam. The length of time an engine may be kept in service will also depend on the roundhouse inspection and care given at the terminals of the divisions. Observance and attention to little things will often save a failure, maybe a wreck, on the road. The tightening of nuts and the application of cotters may save the bolt, which, if allowed to drop out, would result in serious damage to the engine. In bad water districts the boiler should be washed frequently and thoroughly so as to remove all accumulations of sediment. Careful attention to this work will add much to the life of the flues and the steaming qualities of the engine.

The following card, if properly used, will be found very effective in securing a thorough inspection at the end of each trip. The engine inspector should place a check mark on the square opposite the number of each item as he inspects that part and when the inspection has been completed any defects found should be noted on the back of the card. A work report should also be made out covering the defects found and turned over to the proper person to make the repairs. Before the engine leaves the terminal the inspector should again look the engine over to see that all repairs have been made. The work report and card can then be turned over to the proper authority as a matter of permanent record.

A. B. C. Railroad Company
Engine Inspector's Report.
Engine No.________
________Division________ ____190____

1		Axles	38		Grab handles
2		Ash pans	39		Gauge light
3		Automatic coupler	40		Headlight
4		Air governor	41		Hand rails
5		Air pump	42		Hose
6		Air pipes	43		Injector
7		Air reservoir	44		Injector pipe
8		Air brakes	45		Injector check
9		Air Signal	46		Links
10		Boiler	47		Pedestal braces
11		Bell	48		Pedestal bolts
12		Cylinders	49		Piston rod packing
13		Cylinder cocks	50		Quadrant
14		Cross heads	51		Rods
15		Cab	52		Reach rod
16		Cab fastenings	53		Reverse lever
17		Cistern	54		Rocker arms
18		Driving wheels	55		Rocker boxes
19		Driving axles	56		Running boards
20		Driving boxes	57		Signal light
21		Driver springs	58		Smoke box
22		Draw bar	59		Safety chain
23		Draw bar pins	60		Steps
24		Engine trucks	61		Steam heat
25		Eccentrics	62		Sanding apparatus
26		Eccentric straps	63		Strainers
27		Eccentric rods	64		Stack
28		Expansion braces	65		Shoes and wedges
29		Frames	66		Tank valve
30		Frame bolts	67		Tumbling shaft
31		Frame keys	68		Tender trucks
32		Fire-box	69		Tender wheels
33		Fire doors	70		Valve stem packing
34		Flues	71		Water glass
35		Grate rigging	72		Water glass cock
36		Gauges	73		Whistle
37		Guides	74		Wheels

Light repairs, such as examining pistons, renewing cylinder packing rings, closing rod brasses, replacing bolts, and similar work, are usually classed under what is termed running or roundhouse repairs and are accomplished at the end of the trip before the engine is turned for further service.

When the engine has become so badly worn that a general over-hauling and renewal of parts are necessary it is then sent to the back shop for either general or certain specified repairs.

On roads having a large number of engines of different types, and a number of small shops, general or even light repairs cannot be accomplished to the best advantage unless the engines are regularly assigned to certain divisions. Where locomotives are regularly assigned to certain parts of the road, the master mechanic in charge of repairs can so arrange his stock of material as to immediately meet the requirements of the engines on his division and general repairs can be made in the shortest possible time. But where the shop manager has no means of knowing what classes of engines will be sent to his shop for repairs until he has actually received the engine, it is impossible to carry in stock the necessary parts to make quick repairs.

A report may be made by the master mechanic to the shop superintendent prior to the time of forwarding the engine, setting forth in detail what repairs will be necessary, but it will usually be found that something has been omitted and more or less delay will result. Any delay of this kind will entail a loss to the company dependent on the volume of business and variously estimated at from 10 to 25 dollars for each 24 hours the engine is out of service. Locomotive repairs are usually divided into five classes, as follows:

Class 1 repairs — $2,500.00 and over.
Class 2 repairs — 1,500.00 to $2,500.00
Class 3 repairs — 500.00 to 1,500.00
Class 4 repairs — 100.00 to 500.00
Class 5 repairs — 10.00 to 100.00

The Erecting Shop.— Work in this department should be classified and a certain part of the repairs on all engines in shop assigned to individual gang foremen. It was formerly the custom to assign each gang foreman to a certain number of pits in which case all necessary erecting shop repairs to an engine was completed by a few men. This practice is still followed in some shops to the detriment of economic operation. When workmen are regularly assigned to certain clases of repairs they become specialists and are able to accomplish the work quicker and easier than it is possible without classifications. This distribution of the erecting work should be arranged about as follows:

Gang No. 1. Stripping work, such as rods, motion work, guides, pistons, steam chests, brake rigging, injectors, pipes, pilots, cabs, frames, cylinders, trucks, etc.

Gang No. 2. Replacing frames and cylinders, chipping and filing frame jaws, fitting pedestal shoes and wedges, removing wheels and wheeling engines, overhauling and applying spring and brake rigging, trucks, etc.

Gang No. 3. Replacing all boiler mounting, overhauling pops and whistles, removing, overhauling, and replacing steam and dry pipes, laying out all new boilers for location of gauge cocks, drilling, lapping, and applying all studs in boiler, applying injectors, lubricators, etc.

Gang No. 4. Putting up all motion work, such as links and hangers, eccentrics, eccentric straps and rods, rocker boxes, reach rods, reverse lever, lift shaft, setting valves, lining guides, putting up valves, steam chests, pistons, etc.

Gang No. 5. Overhauling air pumps, injectors, lubricators, gauge cocks, and gauges, and all air brake attachments, and testing brakes when applied.

The Fitting Department.— This work should be under the supervision of the machine shop foreman, and should include refitting all rods, links, rocker boxes, reverse levers, pistons, crossheads, valves, and similar work. This is necessary on account of the large number of machine operations on this class of work. If the vises and machinery necessary to carry on this work are located in close range, it will enable the mechanics to work together to better advantage, and require less supervision to produce necessary results. It will also avoid trucking the parts from vise to machine and back again, and from one machine to another in different parts of the shop.

Inspection.— When an engine is sent to the back shop for general repairs it should be carefully inspected by a competent man and a condition report made to the shop superintendent. The principal features of this report should then be made out in duplicate and a copy furnished to each foreman and gang foreman in the shop so that all will be well posted as to the work required.

The Shop Foremen's Meeting.— On Friday afternoon of each week a schedule should be made out showing the number of engines to be completed the following week, and the foremen and gang foremen should be called together in a short meeting. The shop superintendent may require statements of the condition of the various departments and each locomotive on the schedule for the following week should be discussed in detail and any expected delays brought to light and accounted for. A half hour spent each week in discussing the general progress of the work in the different departments in a meeting of this kind will, in a short time, produce very gratifying results. Shop improvements, the location of tools to reduce cost of handling material, air jacks, changes in patterns to reduce the amount of machine work, or to increase the strength or wearing of parts, and many other details of the work can be talked over in these shop meetings and if suggestions are carefully carried out, it will soon result in a largely increased output of the plant.

When an engine has been carefully inspected and the foreman of the stripping gang has received a copy of the inspection referred to above, it is set in the shop over the drop pit and is ready to be stripped down.

Some shops are equipped with a drop table. The engine is run onto this table, blocked at each end and all wheels dropped at same time. In other shops a drop pit is constructed with a hydraulic hoist in the centre capable of dropping one pair of wheels at a time. In still other shops no drop pit is supplied and it is necessary to jack the engine high enough to run the wheels out. In shops of this kind, when the supply of air is sufficient, pneumatic telescope jacks should be supplied for removing wheels. The jacks can be mounted on a small pair of truck wheels and by placing two of them alternately under each end of the engine the wheels can be removed in one-half to three-quarters of an hour.

In shops equipped with sufficient crane facilities, the motion work may be cut loose and the engine lifted to a permanent position before further stripping is done. No matter what method may be used to remove the wheels, the rods and attachments should be removed before the engine is put in the shop, loaded on a dummy car, cleaned, and delivered as a whole to the vise men to be refitted. If this can be done conveniently it will avoid much delay and confusion as other parts are being stripped. When the remaining parts of the engine have been stripped, they should at once be properly stencilled, cleaned, and delivered to the different departments for repairs. The card shown in the following illustration will be found very convenient in handling the work between different departments of the shop.

A. B. C. RAILROAD COMPANY

WORK REPORT

Engine No.________In shop__________190____. To be out 190____. Mr.______________________________Foreman

______________________shop. Make following repairs.

When completed return card to____________________

NAME OF PART	DESCRIPTION OF WORK REQUIRED

Above parts delivered to______________________shop

______________________190____. Work completed and card delivered to______________________190____.

NOTE:—Work on this card must be completed and ready for delivery to______________________shop

______________days before engine is marked for service.

This card may be used in any one of the following ways:

1. The general foreman may require each gang foreman or general work inspector to carefully inspect all parts after engine is stripped and furnish to the clerical force in his office all necessary information concerning the requirements of the engine. The cards can then be properly filled out and sent to the respective departments in which the repairs are to be made.

2. The engine being inspected and stripped in the erecting shop, the foreman of this department may require the gang foreman in charge of each class of repairs to carefully inspect his part of the work as soon as it has been removed, and report to his office the work necessary to be done, and the clerk can then make out the card and forward to the respective heads of departments.

3. The gang foreman in charge of the different classes of work may be authorized to make out cards covering the work necessary on their part of the engine and forward to the heads of other departments at the time worn or broken parts are delivered for repairs or renewal. When the parts have been fitted and are ready to apply to engine, the cards may be returned to the gang foreman who first made them out. This will, without further notice, place him in a position to put up the work in the shortest time possible.

These cards may also be used by the machine shop foreman for work required in the blacksmith shop or by any department requiring work from some other department.

Another small card which will be found very convenient for use among different departments is shown below. This card can be used in ordering bolts, and all miscellaneous work which will necessarily be omitted from the general order for repairs, referred to above.

A. B. C. RAILROAD COMPANY

FOREMAN'S CROSS ORDER

______________Please furnish and charge______________

______________190____. ______________________

Foreman.

Shoes and Wedges.—This is one of the most important jobs on an engine, and must receive the most careful attention as it will prevent cutting tires, breaking crank pins, and avoid much trouble with hot driving boxes and cut journals.

In filing the frame jaws much care should be exercised to see that they are made perfectly true up and down and kept square with the outside of the frame. A scraper should be used to insure a good bearing and shoes and wedges should then be carefully fitted to the jaws.

In fitting the pedestal braces the workman should be careful to see that there is no unnatural strain on the jaws of the frame, and if the braces are new they must be clamped firmly against the frame in the position which they will occupy when work is finished, and scribed for slotting. Old braces should be tried in position on the frame and if loose sent to the blacksmith shop to be closed and then refitted to frame. Thimble braces, or braces which fit between the jaws of the frame, may be lined on end if loose and refitted to jaws.

Cylinders.—In fitting new cylinders to shell of smoke box, the cylinders should be placed in proper working position and the arch allowed to rest on the saddle. Level the boiler with the cylinders. Line both cylinders and divide firebox central with lines. Drop plumb line over top of boiler and keep firebox plumb with both lines.

If the saddle will finish so as to hold the boiler the proper height, it may be laid off in this position and circle chipped to fit smoke box. If the circle of the saddle is too large for the boiler and will not true up, a piece of sheet iron or boiler plate can be used and the thickness of the same figured in laying off.

Boring Old Cylinders.—In placing the boring bar in old cylinders, be careful to set it with the counterbore of the cylinder at each end, or if back head is in place, a taper gland may be used in the stuffing box. If cylinder is badly worn, two roughing cuts will be required, and if the bar has the necessary power, the speed should be 30 to 40 feet per minute with a feed of at least ⅛ inch. The finish cut can be taken with a wide nose tool at same speed but with a feed varying from ½ to 1 inch per revolution of bar. If required, each end of cylinder should be re-counterbored with offset tool. Sometimes the tool will chatter, and this may be largely relieved by hanging a heavy weight on the back end of the bar.

Cylinders are counterbored to prevent psiton from wearing a shoulder at each end, and this counterbore should extend back far enough so that the outside packing ring will just pass over the inner edge.

Rods.—The length of main rods can be obtained by placing crosshead in exact centre of guides and using a square from centre of main driving box. One end of a stick can be placed against the crosshead pin and a line scribed on back end of stick to coincide with centre of main box. Then all one-half the diameter of the crosshead pin and the result will be the proper length of the rod. In adjusting main rods to proper length, the position of the key with reference to the pin should be noted. When the key is in front of the pin, the rod is lengthened as the brass wears, and when behind the pin the rod is made shorter as the pin is driven down. The clearance, therefore, should be divided accordingly.

The length of parallel rods may be obtained by measuring from wheel centres when the wheels are under the engine. When the wheels are not under the engine, the distance between the centre of frame jaws can be measured. In either case, if the engine is cold, 1-32 inch should be allowed in length of back rod for expansion on all engines where the fire box sets down between the two back pair of wheels.

In hanging the rods, fill the wheel centres with lead, mark the exact centre of each wheel, and use tram. If the wheels are out of tram, then try the main wheel centres with centre in rocker arms, which are supposed to be right in all cases, and set shoes and wedges where needed so as to bring wheels to tram and also to keep them square with rocker boxes. When the main wheels are arranged in proper position, the others can be changed accordingly. Shoes and wedges should be set moderately tight before tramming main centres.

When pins all tram, pinch one side of engine on dead centre and put up rods on that side. Then pinch the other side the same way and hang rods. The rods should be closely lined between the pins.

In fitting the brasses to the top straps, file out top and bottom to give a good side bearing. Key the brasses up and try on pin, taking out all lost motion to prevent pounding. Rod brasses should always have a good bearing on the pin and should have a Russia iron liner between the halves before boring. They should be tightly keyed up and bored 1-32 inch larger than the pin. After they are bored, the liner should be removing before applying to pin.

Guides.—In lining four bar guides it is best to first put a centre in the crosshead and set guide gauge to it from bottom of head. The bottom guides should then be put up and cylinders lined. Always use a small line and be exact in measurements.

The guides must be kept perfectly true and level with frames across face. The crosshead should be calipered to get width between guides and about 1-32 inch allowed for lateral motion or side play.

The guides must be divided central and kept perfectly parallel with line. A straight edge can be tried on the face of the guides and if they are out in the centre they may be sprung into place with liners.

When the bottom guides are properly set, the crosshead should be put in place and tried in all positions to see that it is true at all points. The top guide can now be put into place and lined down so as to allow the crosshead to work freely.

In lining two bar guides, run a small line through the cylinder. Measure the distance from bottom face of crosshead gib to centre. The bottom guide should be set this distance from line. The crosshead can be calipered and top guides set the required distance from bottom guide.

A gauge must be used on both sides and guides kept central with line and square with top of frame. The crosshead should be put in place and as many liners as possible used under top guide, so that they can be closed as the crosshead wears.

Valves and Steam Chests.—In truing up old valve seats, it is best to use a valve seat-facing machine where one is obtainable. If a machine is not in use it is necessary to chip with chisel and hammer if the seat is bad, then use a bastard file to produce a fine bearing with the face plate or calve. A smooth file or scraper can then be used to bring the surface down to a good bearing. The valve seat must be kept the same height at all points.

To line down the pressure or valve balance plate, get the exact height from the seat for the gasket to the top of the valve, and the thickness of the chest outside of the gaskets. Then allow for the thickness of the gaskets and about 1-32 inch to draw down and the plate to these measurements.

In putting up steam chests and covers in erecting shop, care should be taken to see that the gaskets are well fitted to the grooves in the cylinder. The nuts on the cover must be drawn down very tightly to prevent the steam chest leaking around the joints.

Steam and Dry Pipes.—This is one of the most important parts of the engine and requires some skill in making proper joints between the pipes so that all leaks will be avoided. The joints must be perfect in every respect with as wide face for the flat bearings as possible. If this work is not carefully done, when the engine has made one or two trips in heavy service, more or less of it will have to be gone over again.

In grinding joints, No. 1 emery may be used for all brass to brass joints, and No. 2 emery for all iron to iron joints. The joints should be ground until there is about ¼ inch bearing in the worst place.

If joints are badly worn, face them off in machine or scrape before grinding, A tool similar to a carpenter's brace may then be used in grinding.

Use block and tackle where necessary in applying pipes. When dry pipe is put in place, see that a perfect joint is made between ring on pipe and flue sheet. Fasten pipe securely to dry pipe with key bolts and strap, or flange with bolts and nuts. Be sure to keep top level. Fasten to dome and put in throttle box and throttle. Connect up throttle rigging carefully and securely so that no trouble can occur in the future.

Blacksmith Shop.—In this department it is usually necessary to do more or less car work, track and bridge work in connection with the regular locomotive repairs. To do this successfully, the foreman should carefully classify the work, giving to the furnaces such parts as can be most successfully done in this way, and distributing among the forges the remainder of the work in such a way as to give to each fire a regular class of repairs.

The bolt heading machinery, shears, and furnaces necessary to heat all bolts should be located in close proximity so that when iron is delivered to the shears it can be cut off, the bolts passed to the furnaces, headed and delivered to storage bins with the least possible handling. Such an arrangement as this in any large shop where thousands of bolts are made each month will save much time and money.

Particular attention must be given to the furnace, which should be oil and not coal, to see that it is capable of heating the iron as fast as the machine will head the bolts. Oil furnaces and bulldozers or air bending machines should be provided for car work, such as arch bars, brake hangers, brake rods, etc. For making brake staffs, eccentric jaw pins, and all similar work which can be handled in dies, a Bradley cushion hammer or one of similar make should be used. These hammers are not expensive in first cost, but their use will have a very gratifying effect in reducing the cost of repairs.

DRAW BAR SPRING FOLLOWER PLATES

System.	*Absence of System.*
1. Bar iron brought into shop, cut to length, and put into oil furnace.	1. Bar iron delivered to shears.
2. Remove when hot, 2″ hole punched through to within 1/4″, leaving dowel on opposite side of plate, and plates loaded on iron truck.	2. Plates cut to length, heat in coal furnace, and 1/8″ hole punched.
3. Deliver to store shed.	3. Deliver to smith at forge.
	4. Round bar iron 1-1/8″ diameter delivered to shears.
	5. Cut to 6″ lengths.
	6. Deliver to upsetting machine.
	7. Dowels upset to 2″ and cut off.
	8. Dowels delivered to blacksmith.
	9. Heat in open fire, put in plate and rivet on anvil with sledge.
	10. Deliver to store shed.

BRAKE LEVERS

System.	*Absence of System.*
1. Bar iron brought in, levers cut off and put in oil furnace.	1. Bar iron delivered to shears.
2. Heat, draw out under hammer, cut to length, and load on iron truck.	2. Cut of.
3. Deliver to drill press.	3. Put into coal furnace.
	4. Heat and draw out under power hammer.
	5. Deliver back to shears.
	6. Cut to length.
	7. Load on trucks and deliver to drill.

The above illustration gives some idea of what may be accomplished by a systematic classification of blacksmith work.

Boiler Shop.— Greater gains can be made in this department than in any other, perhaps, by a systematic classification of the work. If no particular attention is given to assigning certain men to certain classes of work, it will soon be found that the output of the plant is being limited on account of slow returns from the boiler shop. The repairs in this department, no matter whether the shop be large or small, may be organized and men regularly assigned to certain operations in the following manner:

1. Ash pans, new and repairs, includes putting upon engine.
2. Flanging flue sheets and door sheets, rolling side and crown sheets and bolting fireboxes together ready to rivet.
3. Riveting, chipping and caulking firebox, putting in place, setting mud ring and riveting complete.
4. Putting on crown bars, driving stay bolts, renewing side sheets, front and back flue sheets, flanging and putting on back door sheet and throat sheet, cutting out, rolling, and applying smoke box.
5. Cutting out all rivets, breaking out staybolts, and removing mud rings, fireboxes, and other parts.
6. Tapping stay bolt holes, screwing in stay bolts, setting to place, and cutting ready to drive.
7. Cutting out flues, removing from boiler and putting in rattler.
8. Setting flues in boiler complete.
9. Flue plant.

Drive rivets with pneumatic hammer wherever possible. Break out stay bolts with pneumatic ram. Chip and caulk by air and not by hand. Use air motor to tap stay bolt holes and screw in stay bolts. Use a small automatic gang drill to drill detective holes in stay bolts. Don't heat them and punch. It destroys the even quality of the iron. Cut out, expand, and roll flues by air. Cut off safe ends with bevel rotary cutter. This cuts and scarfs the piece all in one operation.

W. S. Cozad,
Shop Specialist, Erie Railroad Co.

Railway Mileage and Cost of Construction. The following table, which has been compiled both from the special report of the Bureau of Statistics of the United States Department of Labor and from other authorities, attempts to present a picture of the condition of railroad transportation shortly after the beginning of the 20th century. While it has been possible to obtain a reasonably accurate estimate of the number of miles of railway in each country, the lack of census figures in several cases has prevented the completion of the column relating to population, while the absence of any authentic information concerning the financial standing of the roads has necessitated the omission of the cost of construction, or capital cost, in many countries. The statement follows:

Country.	Year.	Mileage.		Cost of Construction.	
		Total.	Per 10,000 pop.	Total capital or cost.	Capital or cost per mile.
				1,000 of dollars.	
Europe:					
Germany	1904	33,819	5.8	$3,245,368	*$98,443
Austria-Hungary....	1903	23,669	4.7	2,440,650	†
United Kingdom....	1904	22,634	5.4	6,173,126	272,737
France	1904	28,102	7.2	3,295,811	*137,601
Russia and Finland..	1902	35,323	2.9	2,828,753	‡
Italy..................	1904	9,966	3.1	1,077,902	108,212
Belgium	1904	4,237	6.3	405,130	§160,893
Netherlands and Luxemburg	1904	2,095	3.7	52,836	§41,086
Switzerland	1904	2,576	7.7	261,059	*104,969
Spain................	1904	8,607	4.6	....	....
Portugal	1904	1,488	2.7	....	....
Denmark............	1904	1,963	8.0	52,836	*41,086
Norway	1904	1,456	6.4	54,600	32,198
Sweden..............	1904	7,697	14.8	216,719	§44,669
Servia...............	1904	359	1.4	23,324	*69,416
Roumania...........	1903	1,974	3.3	172,457	87,364
Greece	1904	643	2.6	....	....
Turkey and Bulgaria	1904	1,953	2.0	....	....
America:					
United States........	1905	211,074	25.9	11,664,191	55,261
Canada..............	1904	19,611	35.0	1,186,547	60,504
Newfoundland	1904	656	30.2	....	....
Mexico	1904	10,356	7.6	....	....
Central America.....	1904	946	2.2	....	....
Cuba.................	1904	1,583	10.1	....	....
Jamaica	1904	185	2.4	....	....
Porto Rico..........	1904	137	1.4	....	....
Colombia............	1904	400	1.0	....	....
Venezuela...........	1904	631	2.6	37,828	70,972
Ecuador.............	1904	186	1.5	....	....
Peru.................	1904	1,036	2.2	....	....
Bolivia	1904	656	3.6	....	....
Brazil	1904	9,368	6.5	....	....
Paraguay............	1904	157	2.5	....	....
Uruguay	1904	1,210	12.6	52,598	‖52,756
Chile................	1904	2,884	9.5	75,208	*‖154,697
Argentine	1903	11,559	22.5	576,734	49,895
Asia:					
British India.........	1904	27,565	1.0	1,144,794	41,531
Ceylon..............	1904	391	1.0	....	....
Asia Minor	1904	2,000	1.0	....	....
Russian Central Asia	1904	1,658	2.1	....	....
Siberia and Manchuria	1904	5,664	9.8	....	....
Persia	1904	34	0.04	....	....
Dutch East Indies...	1903	1,456	0.5	77,232	53,044
Japan................	1904	4,495	1.0	182,257	40,547
China................	1904	1,176	0.03	....	....
Korea	1904	37	0.01	....	....
Siam	1904	190	0.4	4,998	23,305
Africa:					
Egypt	1904	2,953	3.0	....	....
Algeria and Tunis...	1904	3,041	4.5	131,781	*58,053
Congo State.........	1904	276	....	....	....
Abyssinia............	1903	234	....	....	....
Colony	1904	3,511	14.5	129,603	*50,622
Natal................	1904	744	7.1	54,361	73,066
Transvaal	1904	1,335	9.9	....	....
Orange..............	1904	597	15.5	....	....
British Africa........	1903	292	....	....	....
German Africa......	1903	1,168	....	....	....
French Africa	1904	784	....	....	....
Italian Africa........	1904	17	....	....	....
Portuguese Africa...	1903	616	....	....	....
Australia, etc.:					
Victoria	1904	3,383	28.0	200,581	59,328
New South Wales...	1904	3,281	21.9	205,797	62,729
South Australia	1904	1,901	51.5	71,529	....
Queensland..........	1904	2,927	56.7	101,650	34,718
Tasmania............	1904	620	34.7	18,900	*40,932
Western Australia...	1904	2,144	94.4	43,584	*28,284
New Zealand........	1904	2,403	28.8	100,702	43,253

Notes. * Financial statement for 1903. † Austria, $128,334; Hungary, $74,056. ‡ Russia, $78,553; Finland, $32,189. § State railroad only. ‖ Financial statement for 1899.

Railway Passenger Stations of the World. While there are resemblances between the facilities provided for railway passenger traffic in large cities and at important railway centres in various parts of the world, there are also distinct differences, due to the varying conditions and to the diverse general methods in vogue in the United States and foreign countries.

Generally speaking, large passenger stations may be classified into the following types: *First.— Terminal stations at or near the level of the adjacent streets,* such as the existing Grand Central Station, New York; the Union Station, Saint Louis; the North and South Union Stations, Boston, Mass.; the Liverpool Street, Euston; Great Central, Victoria, etc., London, and Frankfort, Germany. *Second.— Terminal stations elevated above or partly above the streets,* such as the Jersey City Station of the Pennsylvania Railroad, Jersey City, N. J.; Broad Street Station, Philadelphia; Waterloo and Saint Pancras, London; Saint Lazare, Paris; and the Central Station, Antwerp. *Third.— "Through" stations at street level,* such as the Indianapolis Union Station and the Omaha and Saint Paul stations in the United States, and the Hanover Station, Germany. *Fourth.— Terminal and "through" stations combined,* (*a*) at street level; (*b*) above it; (*c*) below it; and (*d*) partly above and partly below street level, such as (*a*) Buffalo, N. Y.: (*b*) Cologne, Germany; (*c*) proposed Pennsylvania Railroad Station, New York, and Waverly, Edinburgh; and (*d*) New Union Terminal, Washington, D. C., Queens Street, Glasgow, Scotland, and Dresden, Germany.

Table I. shows certain features related to operation, and is made up from a recent (1903) investigation of six large passenger stations of the United States, representative of the best practice.

SPECIAL INFORMATION RELATING TO SIX (6) LARGE UNITED STATES PASSENGER STATIONS.

ITEMS	Maximum	Minimum	Average
Train room			
Number of tracks	32	11	20
Scheduled trains per track in 24 hours	32.6	7.4	23
Scheduled trains per track busiest hour....................	2.8	1.2	2.2
Passengers per foot width of all platforms in 24 hours....	446	236	337
Trains			
Scheduled trains 24 hours			
Through.....................	249	46	151.8
Suburban....................	580	80	275.3
Total	829	191	427.1
Scheduled trains in busiest hour			
Through..	38	3	17
Suburban.....................	50	2	26
Total.........................	81	27	43
Maximum No. of trains in 24 hours	854	213	494.3
Maximum No. of trains in 1 hour........................	97	31	46.6
Passengers			
Average number per scheduled train			
In 24 hours..................	178	80.8	115
In busiest hour..............	251	100	188

ITEMS	Maximum	Minimum	Average
On scheduled trains in 24 hours			
Through	22,000	4,566	13,641
Suburban	33,839	16,701	24,509
Total	80,318	21,267	45,820
On scheduled trains in busiest hour			
Through	3,557	709	1,866
Suburban	6,092	2,000	4,581
Total	7,991	4,000	6,448
Maximum in 24 hours	200,000	34,598	104,195
Waiting room			
Maximum number of passengers per square foot of area	7.9	1.9	5.6
Average number of passengers per square foot of area	4.4	1.1	3
Concourse			
Area sq. ft.	60,000	14,814	26,657
Width of concourse	89′	35′	53.3′
Width of gates to trains	11.7′	3.5′	8.3′
Total width of all exits	162′	46′	96.5′
Passengers in 24 hours			
Per sq. ft. of area	3	1	2
Per foot of exit	1,076	284	556
Maximum passengers in 1 hour			
Per 10 sq. ft. of area	10	4	6
Per foot of exit	221	87.1	165
Toilet room			
Passengers in 24 hours per fixture			
W. C.	2,333	686	1,227.3
Basins	7,000	1,933	3,724.1
Urinals	3,878	863	2,406.3
Booths			
Number of telephones	14	1	7
Parcel			
Area sq. ft.	1,625	195	614
Lineal foot of shelving	2,294	50	837
Number of parcels in 24 hours	2,200	2,000	2,100
News — Area sq. ft.	480	180	337
Flowers — Area sq. ft.	500	15	173
Confectionery — Area sq. ft.	500	25	241
Cigars — Area sq. ft.	520	200	360
Restaurant			
Seating capacity			
Lunch counter	185	38	77
Dining room	330	42	20
Passengers in 24 hours			
Per sq. ft. of area	70	4	17
Per seat	1,108	115	305
Cabs			
Area sq. ft. cab stand	16,320	2,952	880
Lineal feet platform at cab stand	250	40	159
Baggage			
Pieces in and out in 24 hours			
Average	5,000	1,200	3,675
Maximum	12,000	1,500	7,198
Pieces per train	16	3	10
Number of passengers per piece	35	8	15
Area per piece sq. ft.	12	2	7
Pieces per lin. ft. of counter	100	18	64
Postal matter			
Tons in 24 hours			
Average	315	12	169
Maximum	350	23	183
Area sq. ft.	12,640	720	3,552
Area per ton, sq. ft.	72	12	43
Lineal feet platform	112	4	45
Scales	1	1	1

There are certain features that do not appear in this table. For example, in Paris it is the custom of the people to go out of the city in large numbers on Saturday and Sunday, especially in the summer time, and, to accommodate this immense crowd, the cars of the Western Railroad running out of the Saint Lazare Station are double-decked. On these days, the facilities of this station are taxed to their utmost and far beyond the ordinary suburban business, which is always very great, particularly since the line was built crossing the Seine to the Champ de Mars

To facilitate the rapid handling of traffic in the station, the train arriving with its load of passengers is not hauled out to allow the locomotive to pass out, but it remains on the arriving track while it is uncoupled and moved and turned by a combined traverse and turntable, and passes out of the station on an adjaceent service track to the water-tank and coal-shutes, and then backs down to its train, couples on, and is ready to haul it out, head on, as soon as it is loaded. The side doors of the cars facilitate unloading and loading, so that the train is ready to be pulled out loaded by the time the engine is coupled on. This plan saves time, saves movements of trains and permits the locomotive to travel head-on whether coming in or going out.

This same plan of car doors in Great Britain facilitates egress and ingress. The writer timed the egress of 500 passengers from an arriving train at the Caledonian Railway Station, Glasgow, and recorded *ten seconds* as the time to wholly empty the train from the instant it stopped at the platform. The Illinois Central World's Fair trains in Chicago in 1893 adopted the same plan with great success in the prompt handling of large crowds. In London there is also an immense traffic on certain days, such as Bank Holiday, when all station facilities are taxed to their utmost.

There are other movements, also, to be taken into consideration in estimating the vast amount of work done at important railway stations. Empty trains called "drafts" or "carriage" trains must be hauled in from the storage yards, and hauled out empty to them. The locomotive which brings in the train must pass out to the round house. To give an idea of these extra movements, the following is quoted from the latest time tables of the South Union Station, Boston, Mass., and the Grand Central, New York:

SOUTH UNION STATION, BOSTON, MASS.

RECAPITULATION

		Week-day trains
B. & A. R. R.		216
N. Y., N. H. & H. R. R.		
Providence Division	310	
Plymouth Division	222	
Midland Division	92	
		624
Grand Total		840
Regular trains		840
Drafts to and from storage yards		389
Light engines to and from engine houses		367
Total movements to and from terminal		1,596

GRAND CENTRAL STATION, NEW YORK.

RECAPITULATION

		Week-day trains
N. Y. C. & H. R. R. R.		
Harlem Division	103	
Hudson Division	129	
		232
N. Y., N. H. & H. R. R.		125
Harlem Line storage trains		109
Storage trains 46th Street Yard		227
Light engines to and from engine house		345
Total movements to and from terminal		1,038

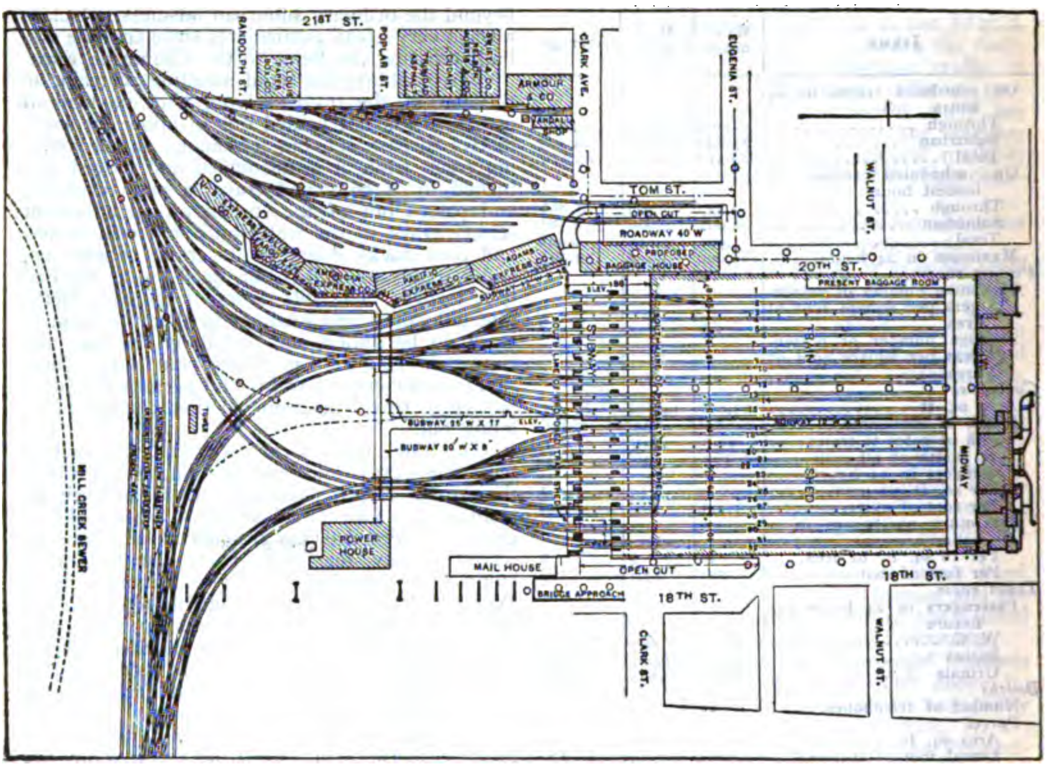


Plate I.— Approach Tracks to Union Station, Saint Louis.

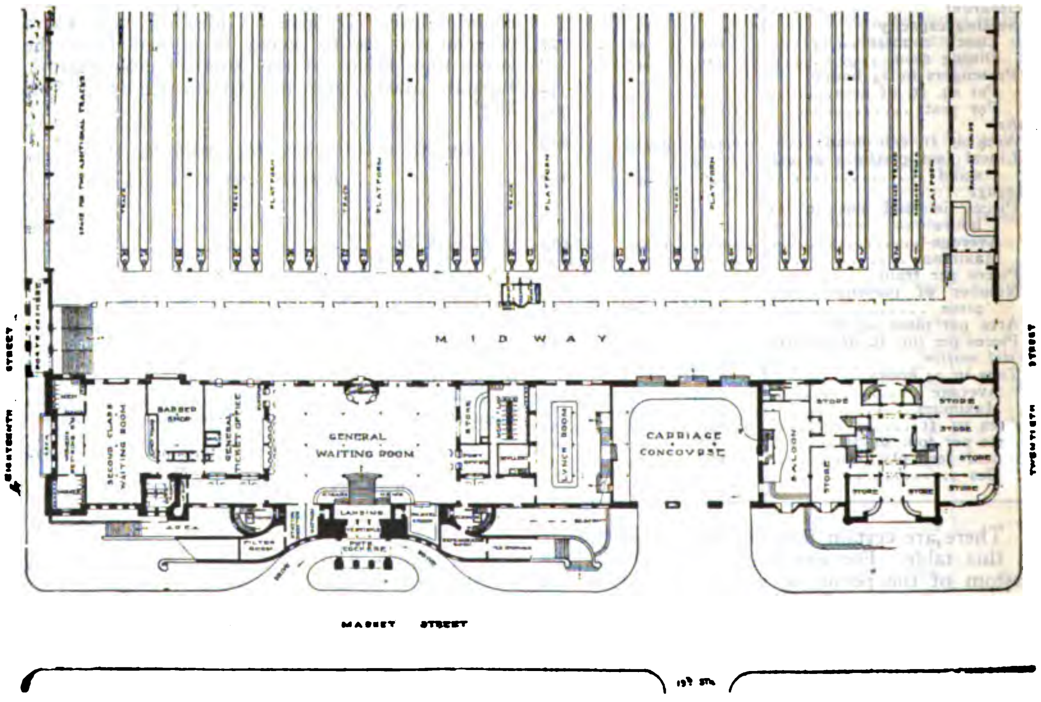
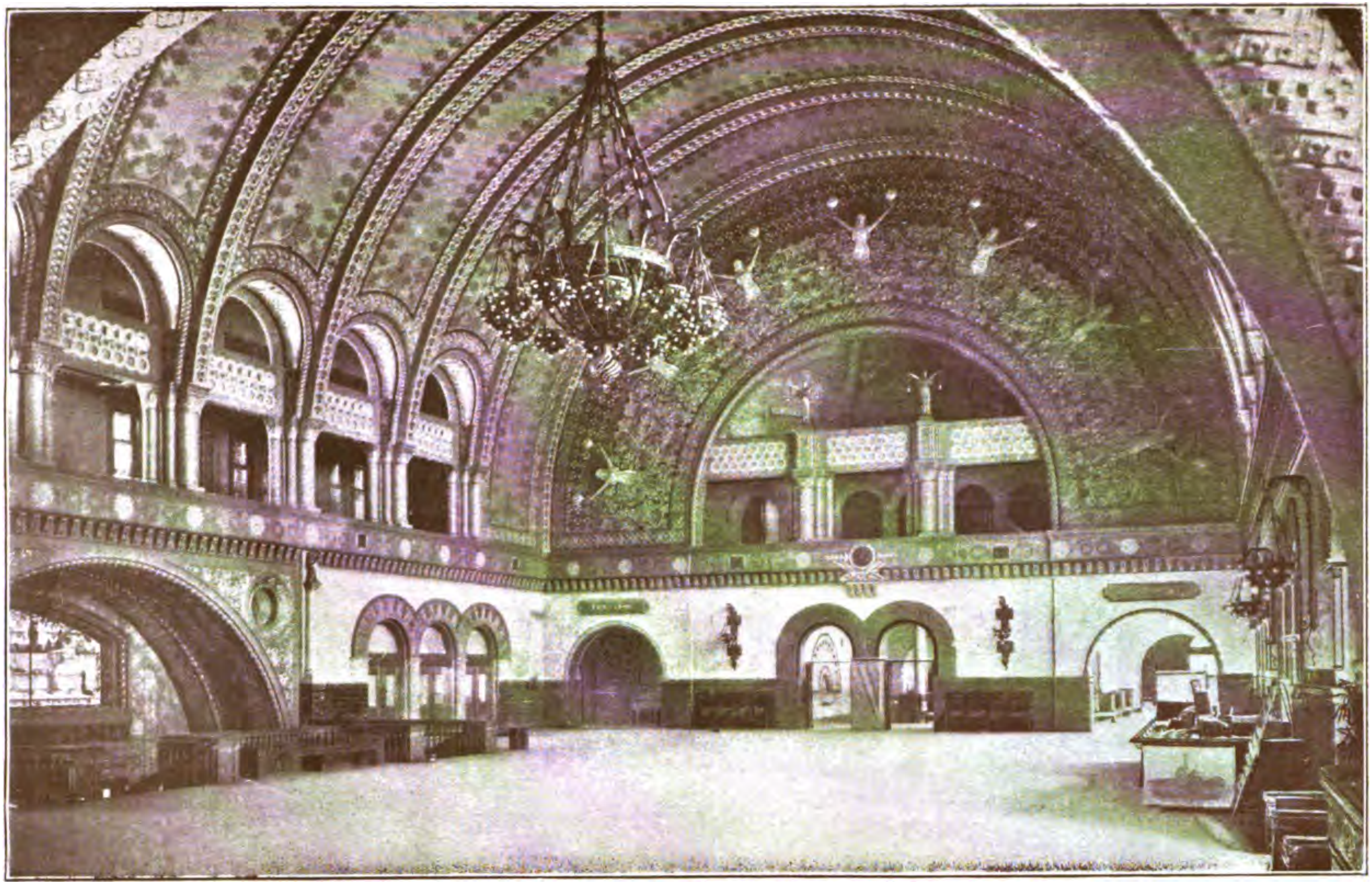


Plate II.— Ground Floor: Midway and Tracks, Saint Louis.



GRAND HALL, UNION STATION. ST. LOUIS.

As 88 regular scheduled trains arrive and depart during the busiest hour — 5 to 6 P.M. — at the South Union Station, Boston, the number of movements required to accomplish this regular train work is very great, and the signal and interlocking mechanisms must necessarily be of the most approved kind.

It is quite common, however, to find a great number of regular train movements in stations that do not rank in size with the two above mentioned. In 1901 the Union Station, Saint Paul, Minn., was handling 202 regular trains on ten station tracks, of which 92 per cent had to be handled on six tracks, which required, between 8 and 9 A.M., 96 train movements, and all this was done with hand switches. This station is used jointly by ten important western railroads, and is a very busy station. One million pieces of baggage were handled in 1901 — a daily average of 2,216. The average at the Grand Central Station, New York, in the same year was 2,654 pieces.

It is interesting to know something of the character of the approaches to large passenger stations over which so many trains pass daily, and especially during the busiest hour. The information can best be given in a table where the work to be done and the facilities in the way of approaches are placed side by side.

TABLE SHOWING APPROACH TRACKS AND TRAFFIC ON THEM.

STATION	No. of approach tracks	No. tracks in station	Trains in 24 hrs.	Trains in 1 hr. maximum	Ratio between sta. tracks and approach tracks	Remarks
Jersey City, Pa. R. R.	5	16	281	25	3.2	Terminal
Reading Ter., Phila.	4	13	417	39	3.2	Terminal
North Union, Boston, Mass.	8	23	588	66	2.9	Terminal
Grand Cent., N. Y.	4	18	357	34	4.5	Terminal
South Union, Boston, Mass.	10	28	840	88	2.8	Terminal
L. S. & R. I., Chicago	4	9	182		2.2	Terminal
Broad St., Phila.	6	16	470	43	2.7	Terminal
St. Louis, Mo.	6	30	237	39	5.0	Terminal
Union Depot, K. C.	4	13			3.2	Through
Erie R. R., Jer. City	2	10			5.0	Terminal
Central R. R. Jer. City	2	12			6.0	Terminal
D., L. & W., Hoboken	2	10			5.0	Terminal
West Shore, Weehawken	2	15			7.5	Terminal
Liverpool St., London	6	20	1094	83	3.3	Terminal
Waverly, Edinburgh	4	19	1101	76	4.7	8 stubs So. 7 " No. 4 through.
London Bridge, London	8	25			3.1	Through
Waterloo, London	6	18	966	61	3.0	Terminal
Euston, London	4	13			3.2	Terminal
St. Pancreas, London	3	9			3.0	Terminal
St. Lazare, Paris.	6	31	1200	74	5.2	Terminal
Dresden, Ger.	4&6	14	808	49	1.4	From two directions thro. & ter.
Cologne, Ger.	6&2	14	300	13	1.8	two dir. Ter. & thro.
Frankfort, Ger.	11	18	478	31	1.6	Terminal
Hanover, Ger.	6&4	9			1.0	6 one end 4 the other "through"

The foregoing table is indicative of the traffic over approach tracks, but one should know the methods of handling it. All of the approach tracks may not be available for the traffic, and the ratio of station tracks to approach tracks, and of trains, as they appear in the table, may be very misleading, if we expect to learn from it just how many movements there are in the busiest hour over each track. One or more tracks may, for good reasons, be at that time comparatively idle, while another may be hot with wheels passing over it. The writer is enabled to show the actual number of movements over one of the approach tracks at the Grand Central Station, New York, on 21 March 1904. There are four approach tracks, and by the station time card there are in the busiest hour 34 arrivals and departures, or 8.5 trains per track in that hour, as per the above table.

There are 18 tracks in the station. This is at 45th Street. At 49th Street these tracks converge into four tracks, to enter the approach to the tunnel. They are numbered from east to west. Nos. 1 and 2 are south bound (toward the station) to 54th Street. (This road runs left-handed from a point some miles out into the station.) From 54th Street, south, for a distance of about 1,600 feet all south bound traffic is confined to track No. 2 — No. 1 being used as a north bound track for shop trains and engines crossing over to tracks 3 and 4 at 54th Street.

This crossing point is the busiest piece of track on the approach, and for the hour between 8 and 9 A.M. there are 25 scheduled trains and 5 light engines south bound, and 8 trains and engines north bound, passing over this stretch of track — 38 distinct movements in one hour, or one in every 1.6 minutes. This is not an exceptional performance, but daily practice. The information is given for the encouragement of any railway companies which contemplate a busy traffic over a small number of tracks.

It is possible in the space allowed to briefly give only the specially interesting features of one or two of each of the four classes, or types, referred to at the beginning of this article.

As illustrating the first type, namely, terminal stations at street level, the Union Station, Saint Louis, and the Frankfort Station, Germany, have been selected.

The second type, namely, terminal stations elevated or partly elevated above street level, is illustrated by the Reading Terminal, Philadelphia, and the Saint Lazare, Paris.

The third type, namely, through stations at street level, is represented by the Indianapolis Union Station.

The fourth type, namely, terminal and through stations combined, partly elevated or depressed, the Union Terminal, Washington, D. C., now under construction (April 1904), and the Dresden Station.

The Saint Louis Union Station is one of the largest in the world, for it has more tracks than any — 30, with space for two more in the train shed, though not so many trains arrive and depart as with some other stations. Its traffic, however, is very important, as it is the terminus of 22 trunk lines and the trains are mostly through trains — very long and heavy. The trains approach from two directions, from the east over the two bridges that span the Mississippi River, and from the west by trunk lines from that direction. The original lay-out of the approach tracks had serious objections and radical changes are now being made to improve the entrance to the station.

Plate I. shows the new approach tracks, increasing the number from four to six. It will be seen that these approach tracks spread out into really four groups upon entering the immense train shed. The plan of the ground floor of the station, with the «Midway»— concourse — and the station end of the track, is shown on Plate II. A good idea of the interior may be had from Plate III.— showing «The Grand Hall.» The station is owned by «The Terminal Railroad Association of Saint Louis.» The roads using it form the proprietary company. The total first cost was $6,500,000 — the real estate costing $4,500,000, and the buildings, etc., $2,000,000. The cost of operation during the year 1898 was:

Rental	$327,507.40
Less revenue from privileges	103,526.51
Net rental	$223,980.89
Actual operating expenses and maintenance.	296,636.44
Total annual cost	$520,617.33

The average charge per car for that year was $1.58. The cost is apportioned among the roads using the station on a «wheelage» basis. This word must not be understood to mean wheels. It means cars (coaches), and the charge is on the basis of «equalized cars,» as explained below. The following paragraph from the agreement between the Association and the various railways occupying the station will show clearly the method of apportioning the cost:

> An accurate record shall be kept by the Terminal Company of all passenger, baggage, mail, express, sleeping, dining and special cars, in and out of the said Union Station during each calendar month, and said Railway Company shall pay said Terminal Company such proportion of said balance, as the number of such cars of said Railway Company in and out of the said Station, bears to the whole number of such cars in and out of lines using said Station facilities during the month; and in so ascertaining the number of such cars in and out, cars hauled in trains, the runs of which terminate within 37 miles of said Union Station, shall be counted as one-third part of a car, in all other cases as one car.

Frankfort-on-the-Main, Germany.— This station is owned by the Prussian government and the Hessian Ludwigs Railroad. It is really a street level station, the entire area in front and on the sides having been raised and embellished with grass plots, parks, and ample approach area. The general railroad approach differs from that at Saint Louis, as groups of tracks come into it direct. In order to prevent grade (level) crossings, the tracks approaching from different directions are at different levels for some little distance from the station, those coming in from lateral directions passing over those entering directly. The train shed is very large, but not equal to that of Saint Louis, being 551 feet by 610 feet with an area of 336,110 square feet, while the Saint Louis train shed is 606 feet by 700 feet, with an area of 424,200 square feet; and there are 18 tracks in the train shed at Frankfort. Plate IV. is a photographic view of the front of the station, and the train shed is seen in Plate V. The latter shows clearly the three great steel arches and the very substantial and permanent character of the wide platforms. The platforms of all large German stations are generally much more solid and are much wider than is often found in the United States.

The Reading Terminal, Philadelphia, is a characteristic station of the second type, elevated above the street. The train shed is one single metallic arch, three-pointed, hinged at the crown and covering the entire width of the tracks and platform, the width at springing line being 260 feet. The height is 88 feet, the length 502 feet. The total length of the station, including the head house, is 663 feet. The 13 tracks starting in the train shed reduce to 5, 350 feet from it. About 1,650 feet from it, they separate into two lines of two tracks each. The terminal yard is reached over an elevated structure, the plate girders bridging the street, or viaduct, on columns. This structure is half a mile long. The elevation of the rails is about 25 feet above the street level.

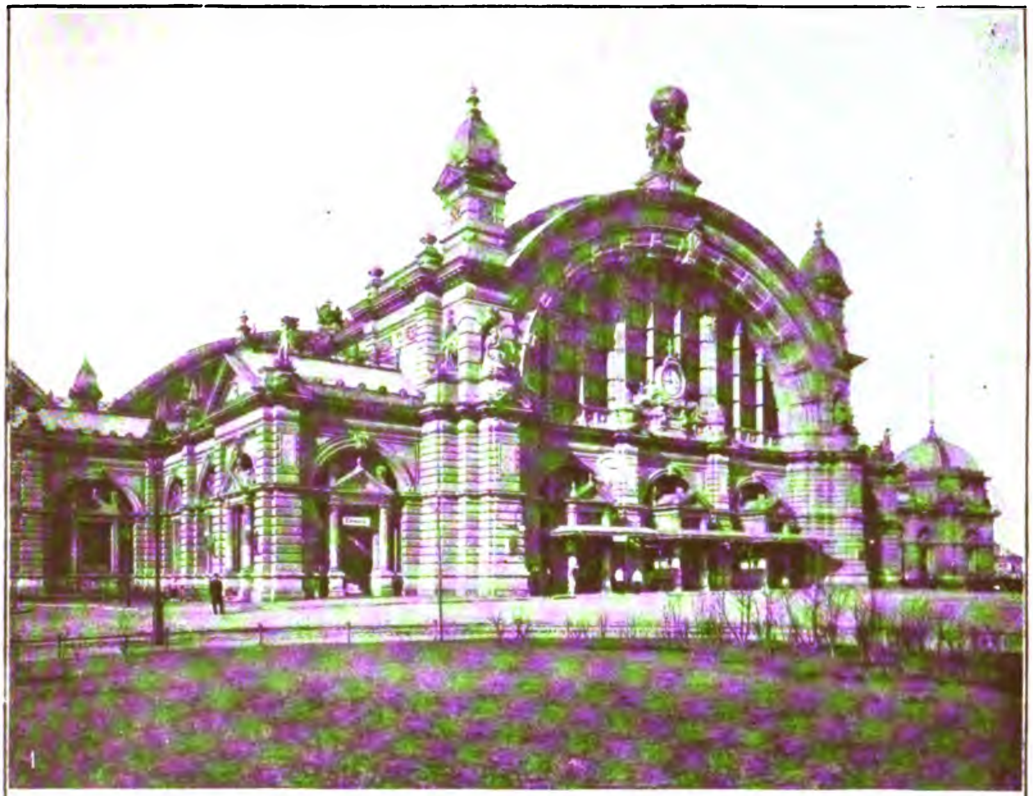
The station proper is in the second story of the head house — the ground floor being used for entrance, waiting rooms, ticket offices, baggage rooms, etc. The general and administrative offices are above the second story. The ground floor under the train shed is used for a large market, cold storage, and a refrigerating plant. The operating plant of the station is also here. The main waiting room on the second floor is very lofty, occupying two stories in height. There are also on this floor the dining, lunch and smoking rooms.

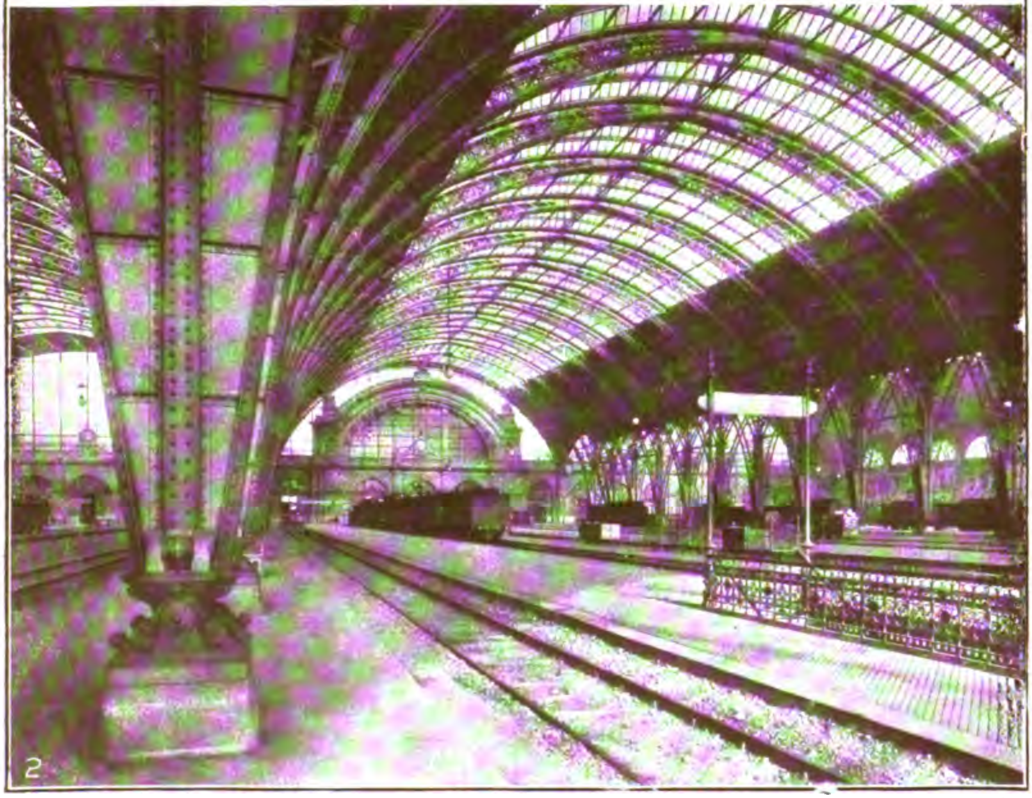
There are two large passenger elevators and a broad stairway. Each baggage room has two elevators (lifts) for baggage trucks to the train-shed floor. There are four more stories for offices. The floor of the elevated train shed is constructed of buckled plates carried by plate girders. There is a layer of cement over the plates and then one inch of Neuchâtel asphaltum. The cross-ties are laid in asphalt concrete, the platforms being made of the same material. The surface of the platforms is eight inches above the rails. Large frames of heavy hammered glass are built into the platforms to help in lighting the spaces underneath.

The building is a monumental structure, Italian renaissance in style, the exterior faces on the streets being of pink granite to the first story, and above that pink brick and cream terra cotta.

Some items of cost may be of interest. The head house cost $36 per square foot of superficial area, or 23.1 cents per cubic foot of contents. This cost is for construction alone, and does not include heating, lighting, elevators, water supply, etc. The train shed, including foundations and apartments underneath, cost $8.53 per square foot of surface covered. Plates VI. and VIa. show respectively the ground floor, and section of train shed and foundations.

The Saint Lazare Station of the Western Railway, Paris, is an example of a terminal station, partly elevated and partly at street level. In front of the station the rue Saint Lazare is considerably below the level of the tracks, but on the eastern side the station tracks are at the level





1. Front View of Station, Frankfort, Germany. 2. Train Shed of Frankfort Station.

of rue d'Amsterdam. The ground still rises and the rue de Londres is considerable above the level of the approach tracks and a little further on, at the rue Saint Petersburg, it requires a car lift of about 31 feet to raise the express freight from the track level to the street. There are 31 tracks in the station — 27 for passenger trains and 4 for locomotives and other station service. About a quarter of a mile from the station, the tracks converge into six entrance tracks and pass through a tunnel about 1,000 feet long, and then through a deep cut. Three quarters of a mile from the station, the tracks diverge — two to the west and four to the west of north. Near the point where the lines separate, there is a very large terminal yard. This is one of the best equipped stations in the world. All parts of it, passenger and freight stations, shops, round houses and yards are fully supplied with hydraulic and electric power and light. It has 1,200 daily arrivals and departures of trains. Few exceed it in volume of traffic. It covers 27 acres. Of the various signal towers one commands the three groups of entrance tracks.

In front of the station and connected with it by a covered elevated gallery, is the Hotel Terminus, owned by the railway company. In the interior of the station, reached by several broad and easy stairways, is the Grand Hall "Pas Perdus," 630 feet long and 72 feet wide, from which exits lead to the waiting rooms and offices, etc., which are between this hall and the concourse. The baggage after being raised and registered, is raised to the track level on small trucks by means of movable inclined lifts hauled up by endless chains worked by hydraulic power. (See Plate VIII.) The traverse turntable is shown on Plate IX.

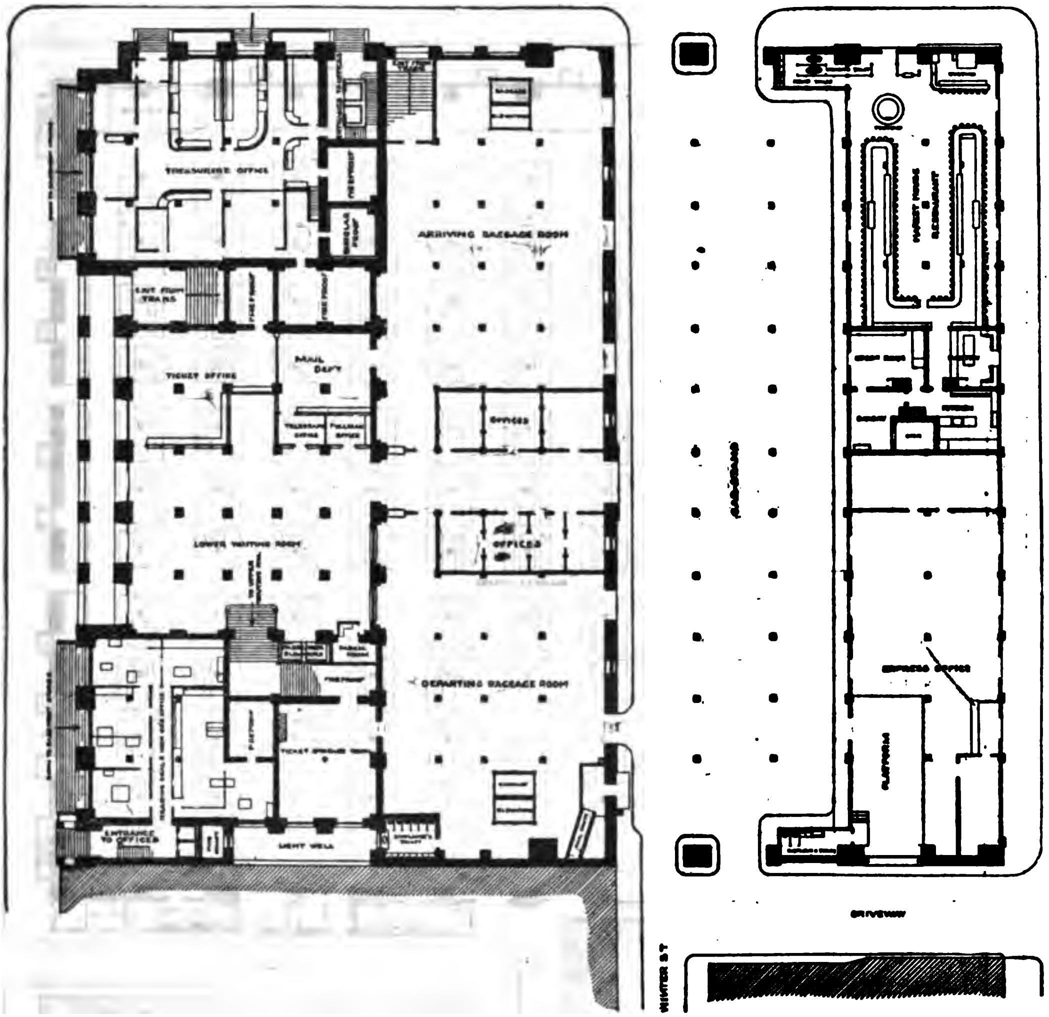


Plate VI.— Ground Floor, Reading Terminal, Philadelphia.

The Indianapolis Union Station is a typical station of the third type, "through" at street level. Five proprietary railway companies united (in 1888) their properties and organized this company. Nine other railways were admitted later as tenants with equal privileges to the five, all having a joint use of the station as well as of a belt line railway. The main building is an imposing and commodious structure, devoted almost exclusively to Union Station purposes.

Adjoining and extending past the head house in each direction, and open at both ends for through tracks, is a train shed 740 feet long and 200 feet wide, with nine passenger and two freight tracks. The entire station cost about $1,000,000. The operating expenses per annum averaged in 10 years — 1889–1898 — $60,000 or 23.7 cents per car. The annual fixed charges were about $52,000, or 20.49 cents per car, to which should be added $11,500 for track expenses, or 11.06 cents per car, making a total of about $123,500, or 55.5 cents per car.

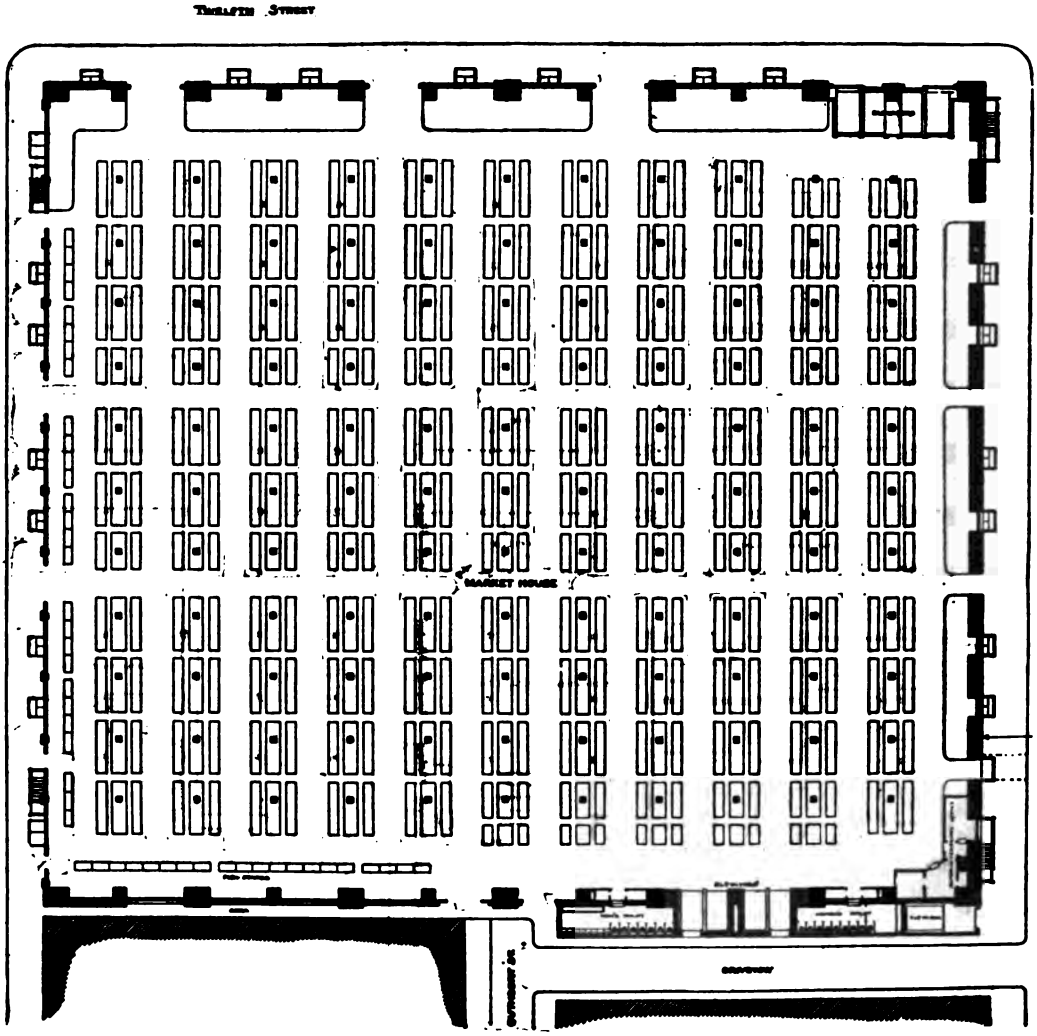
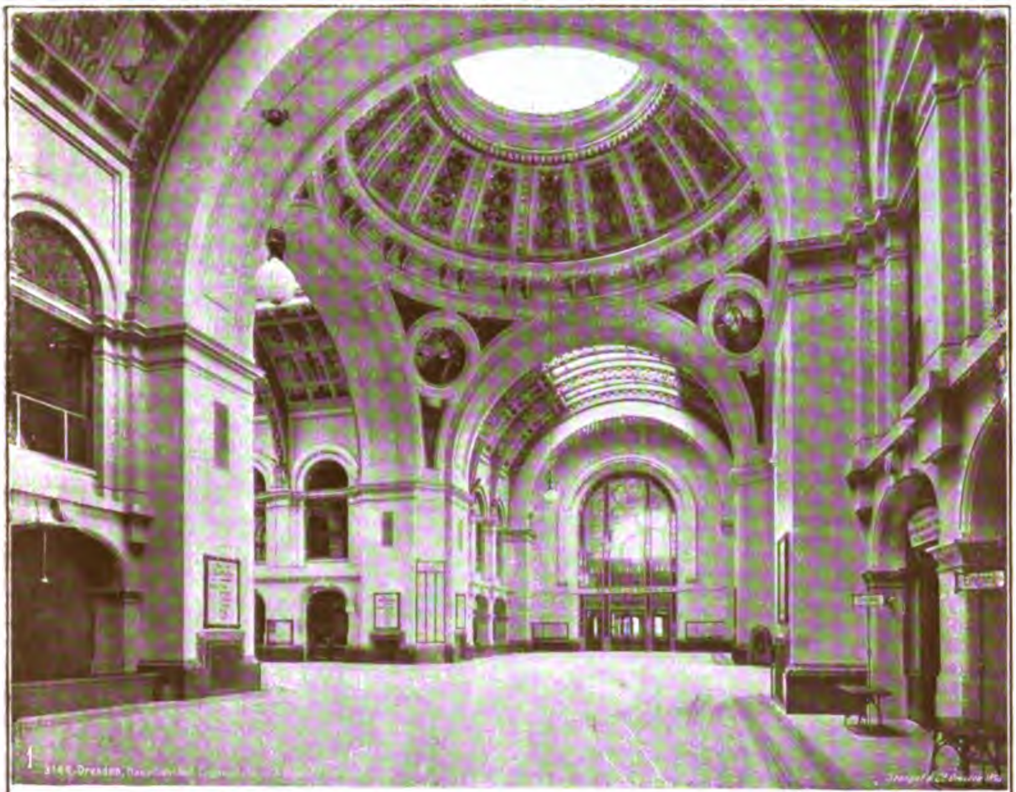


PLATE VIa.— Market House, Reading Terminal, Philadelphia.

The North Station, Hanover, Germany, is an excellent example of a continental through station at street level. Hanover is an important city of Central Germany on through lines from Frankfort to Hamburg and Bremen, and from Cologne to Berlin. Four important roads occupy the station. The general plan comprises a commodious head house 566 feet long and 92 feet wide, and, back of it and attached to it, a train shed of about the same length, 289 feet wide, with nine tracks. The station is furnished with hydraulic and electric power and appliances. The cost of the station with freight depots and other appurtenances, was $5,315,000.

The Union Terminal, Washington, D. C., now under construction (April, 1904) is a good example of a terminal and through station combined — the fourth type. It is partly at street level and partly below the same. The six railroads, four from the south and two from the north, have thus far handled their passenger traffic at two stations at a considerable distance from each other, one near Pennsylvania Avenue at 6th Street and one near the Capitol.

The new station is to be near the Capitol. The Philadelphia, Wilmington and Baltimore Railroad reaches it by a connection with its main line entering Washington, and leaves it from the low level by means of a double track tunnel passing under Capitol Hill near the Library of Congress, by which the roads from the south will reach the station. There are 11 through tracks at the low level and 18 terminal stub tracks at street level — five of those above and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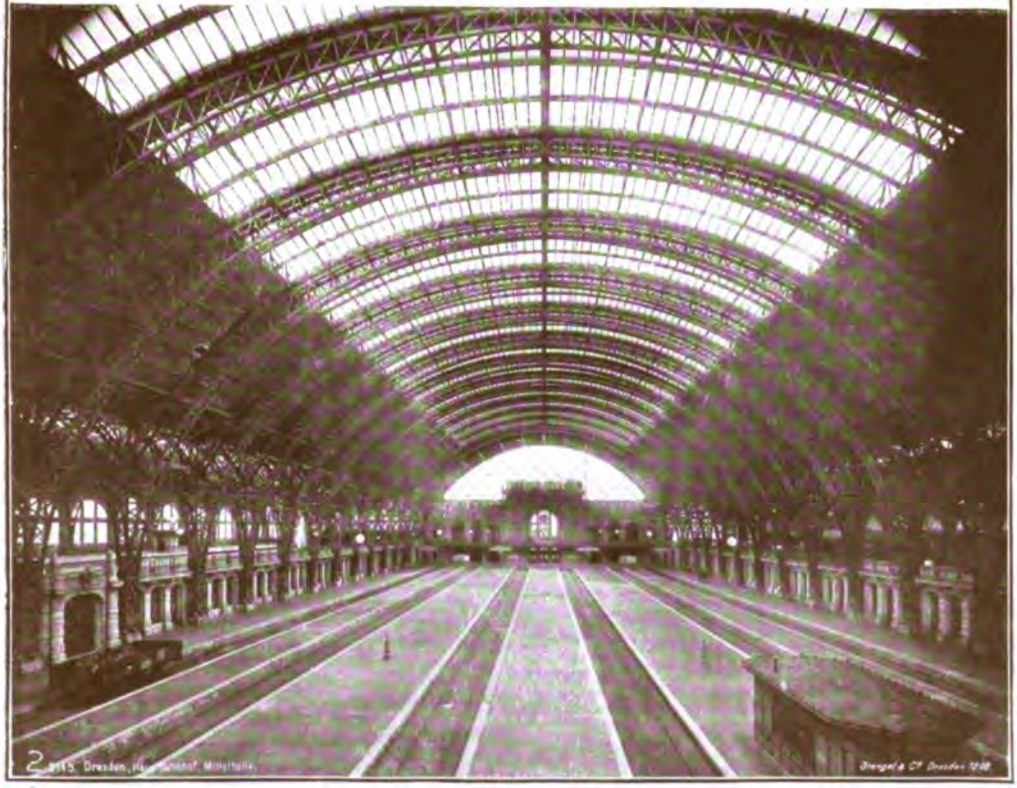
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3145. Dresden, Hauptbahnhof, Mittelhalle.
Stengel & Co. Dresden 1898

INTERIOR VIEWS OF STATION, DRESDEN, SAXONY.

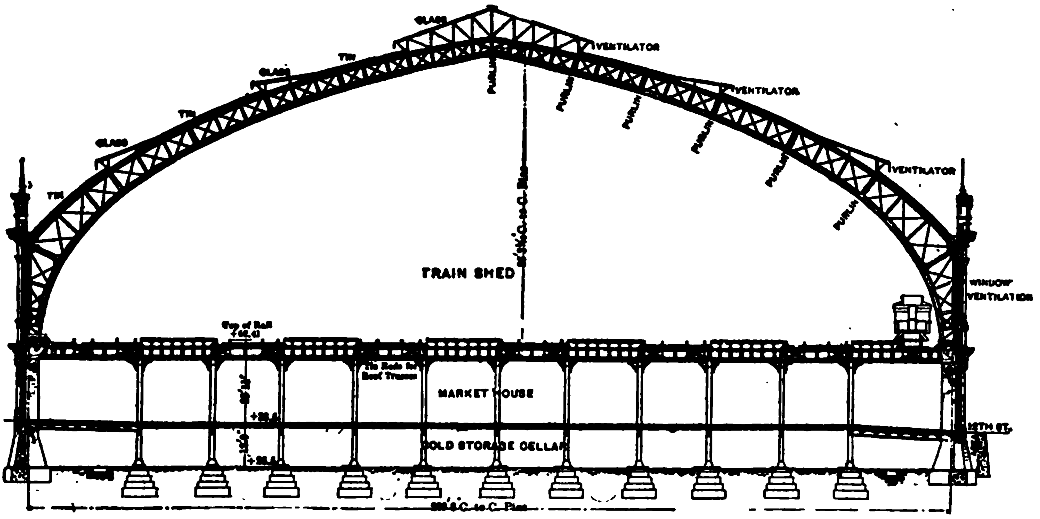

Plate VII.— Cross Section of Train Shed Looking South, Reading Terminal, Philadelphia.

the same number below will be used for baggage tracks. Without going into details, certain interesting features should be referred to. (See Plate X.)

The general government participates in the station by contributing about $4,600,000 toward the elimination of grade (level) crossings and towards the new plaza. It is estimated that the cost of the entire improvement will be about $14,000,000.

The station building proper is about 620 feet long, to be built in white marble and granite. The three entrance arches are 50 feet high, leading into a vaulted open air vestibule. The arches at the end are for carriages, one arch being for the use of government officials, and leading to a suite of apartments for the exclusive use of the President of the United States and the guests of the nation.

Attention is called to the very large size of some of the rooms. The general waiting room is 128 feet by 236 feet and 90 feet high, covered by a Roman barrel-vaulted roof. The concourse is also of extraordinary dimensions, 80 feet by 745 feet, the whole width on both sides of the separating fence being 130 feet. The

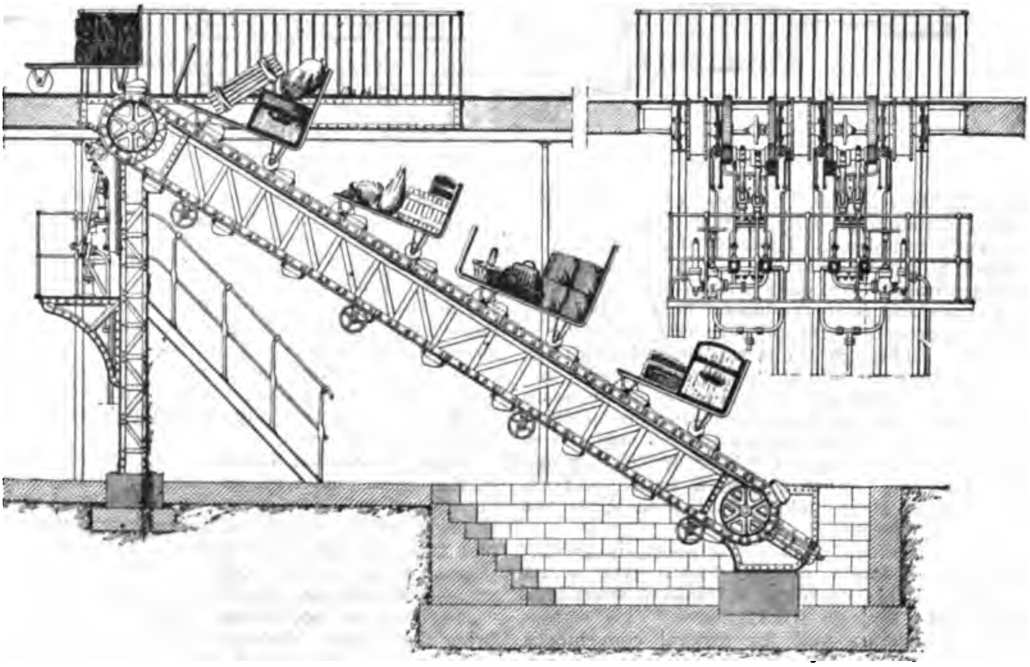

Plate VIII.— Inclined Baggage Carrier, Saint Lazare, Paris.

platforms are covered by umbrella sheds, adapted to the mild climate of Washington. The platforms average 900 feet long and 21 feet wide, made of concrete laid in cinders, and faced with one inch of cement. Plate XI. shows the umbrella sheds.

The baggage is handled in the basement, reached by two driveways. There are four baggage subways, two longitudinal, 16 feet wide, the whole length of the building, and one transverse 60 feet wide at the station end, and one at the outer end of the platforms 20 feet to 42 feet wide. H Street, 80 feet wide, is carried under the station, and K Street, also, outside of the station.

Other interesting provisions are an invalid's room, offices of a resident physician, several mortuary chambers, dressing-rooms with bath, a Turkish bath and swimming pool. The northern approach is on a masonry viaduct crossing over all streets. There are eight tracks upon it.

The Waverley Station, Edinburgh, Scotland, is another interesting example of the fourth type, being wholly depressed, and partly through and partly terminal. The cost of its construction, including property, was $7,500,000. It was recently completed. The cost of operating it is about $165,000 per annum. It has a large passenger traffic — 630 daily arrivals and departures of trains and 40 in the busiest hour. There are four approach tracks on each end and both in tunnels. Through trains can pass through the station on each side on two through tracks, and there are 8 platform terminal tracks on the south end, and 7 on the north end. In general physical features the approaches and the station area are somewhat similar to those of the proposed Pennsylvania Railroad station in New York, reaching it from under the Hudson River and the East River.

The Dresden Station, Germany, is another European station of the fourth type worth noting. It has six terminal tracks at street level and eight through tracks above. This station, for architecture and for general convenience, cannot be surpassed. The materials of construction are stone, iron and glass with a profusion of tasteful ornamentation within and without. It has all the numerous and special conveniences of the most modern United States stations, and one feature not often found in this country, and that is abundant station service — porters, waiters, etc., in which European stations are generally far in advance of stations in the United States. The station is everywhere brilliantly lighted by electricity and is always a model of cleanliness. There are two waiting-rooms for first and second-class passengers, and two for third and fourth, with several restaurants. There is a police station, branch post-office, telegraph, telephones, a physician always in attendance, with the usual other facilities. (See Plate XII.)

The foregoing descriptions and illustrations, and the tables and plates, are sufficient to give an idea of the facilities in the United States and in some other countries where large numbers of passengers are handled. The increase of passenger traffic in many large stations has compelled enlargement of facilities. Old stations, which a few years ago were considered ample, are now under reconstruction to avoid either the congestion and inconvenience in the station or its approaches, or to eliminate the dangers of level crossings of railroad tracks or streets.

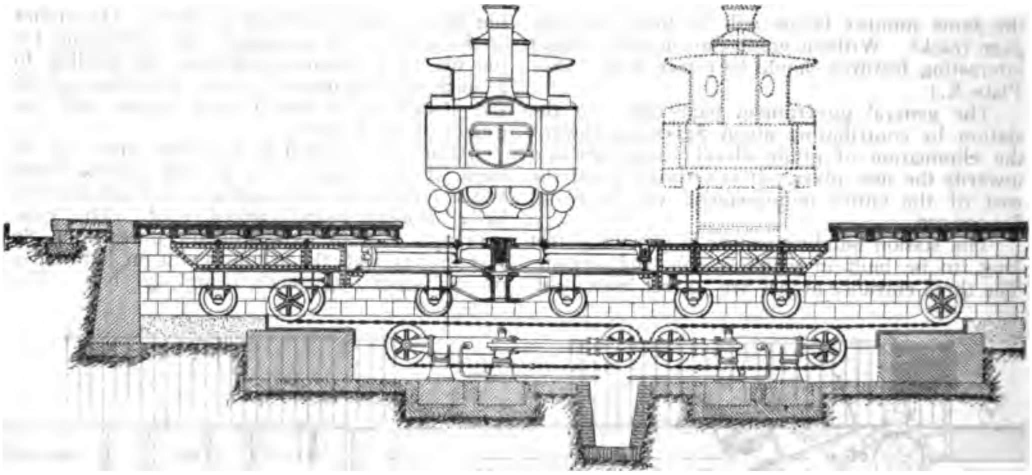

Plate IX.— Combined Traverse Turntable, Saint Lazare, Paris.

In Chicago the Lake Shore and Michigan Southern Railroad and the Rock Island and Pacific Railroad have recently entirely rebuilt their joint station, raising their tracks 15 feet above the street level.

In Great Britain the large Caledonian Railway station in Glasgow, the principal terminal of that road in that city, is being greatly enlarged and improved.

Waterloo Station, London, one of the largest in the world, and with an immense traffic, has been found to be inadequate for its business and is being wholly rebuilt on an entirely different plan from the old station, which in the course of years had grown by additions which had destroyed entirely the unity of the original design.

In Paris in 1900 it was found necessary to bring the Orleans Railway farther into the city, and an approach several miles in length was built along the bank of the Seine below the

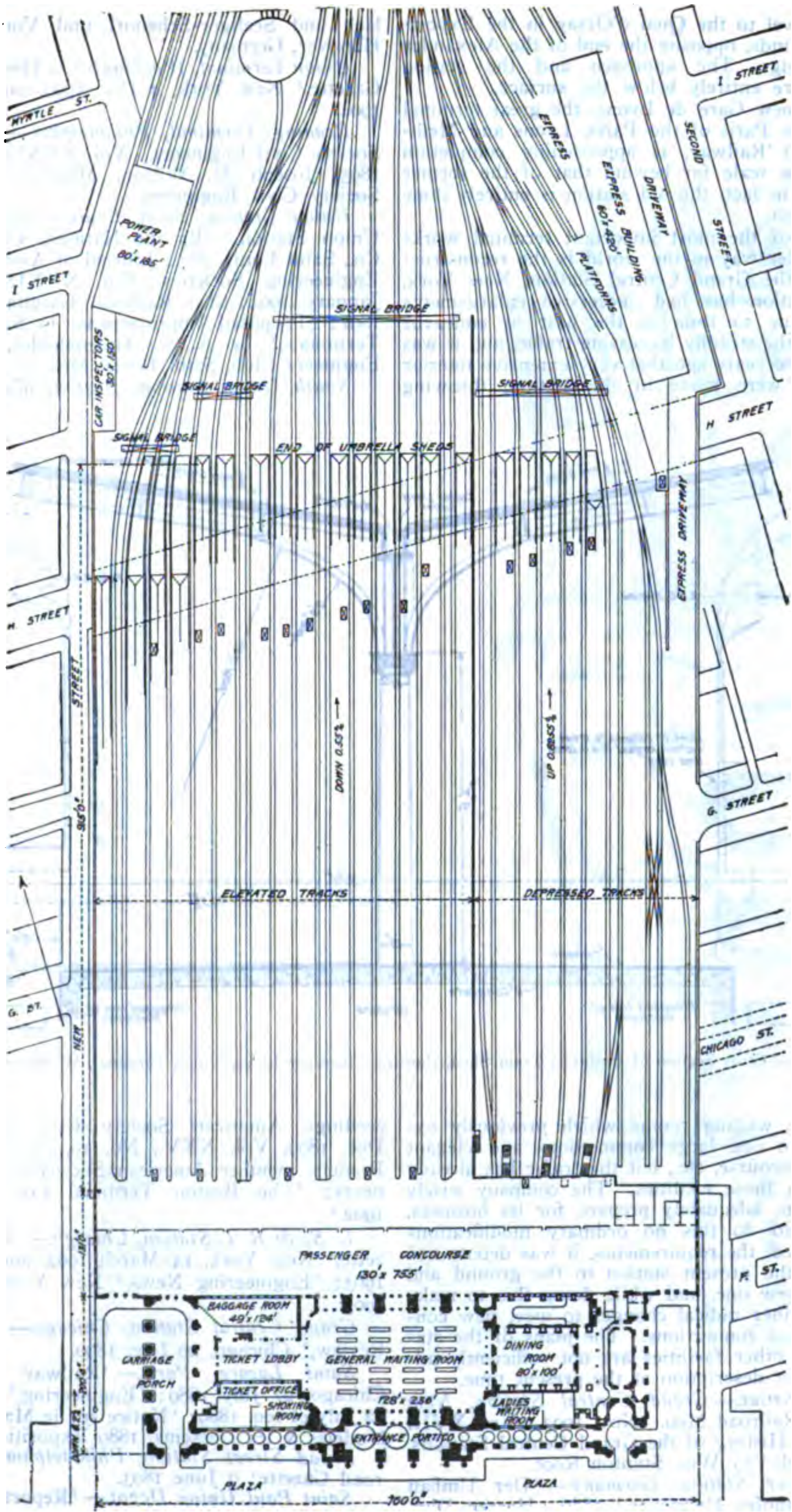

Plate X.— Plan at Street Level. Union Terminal, Washington, D. C.

street level to the Quai d'Orsay in the Exposition grounds, opposite the end of the Alexander III. bridge. The approach and the station tracks are entirely below the surface.

The new Gare de Lyons, the great terminal station in Paris of the Paris, Lyons and Mediterranean Railway, is approaching completion and on a scale far beyond that of the former station; in fact, the old station is entirely done away with.

One of the most important terminal works now under way in the world is the reconstruction of the Grand Central Station, New York. This station has had successive enlargements from time to time in the past to endeavor to meet the steadily increasing traffic, and it was only three years ago that very extensive interior changes were made in the station, throwing the three waiting rooms which previously existed, into one large commodious and elegant room, concourse, etc., but the traffic has already outgrown these facilities. The company wisely decided to adequately prepare for its business, but, as to do this no ordinary modifications would meet the requirements, it was determined to raze the present station to the ground and build a new one, and while doing this to make certain other radical changes to meet new conditions and connections. The plans of the station and other facilities are not sufficiently advanced for description at the present time.

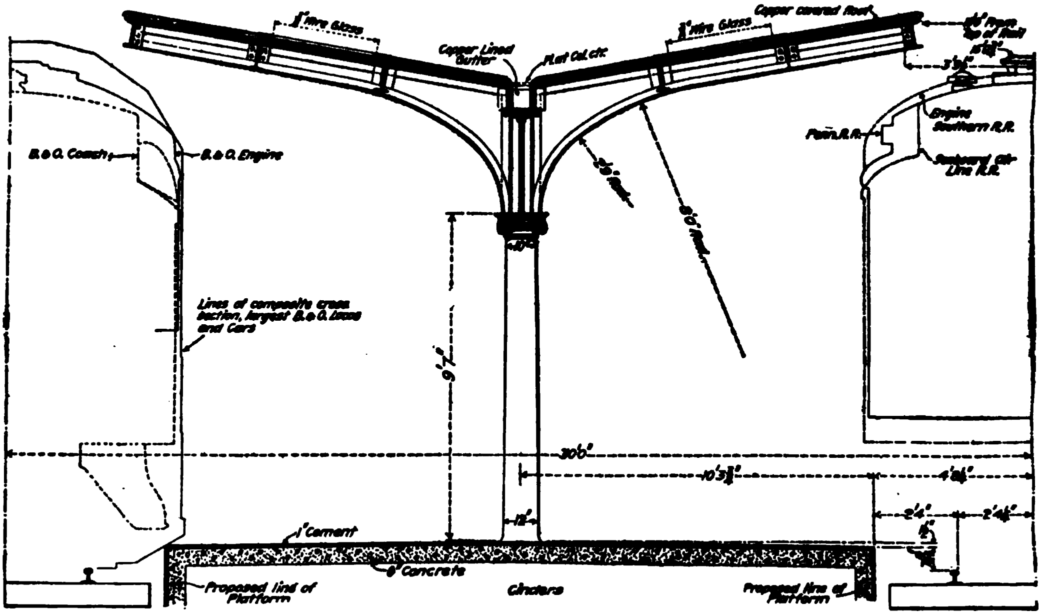

PLATE XI.—Cross Section of Umbrella Train Shed, showing Clearance Lines, Union Terminal, Washington, D. C.

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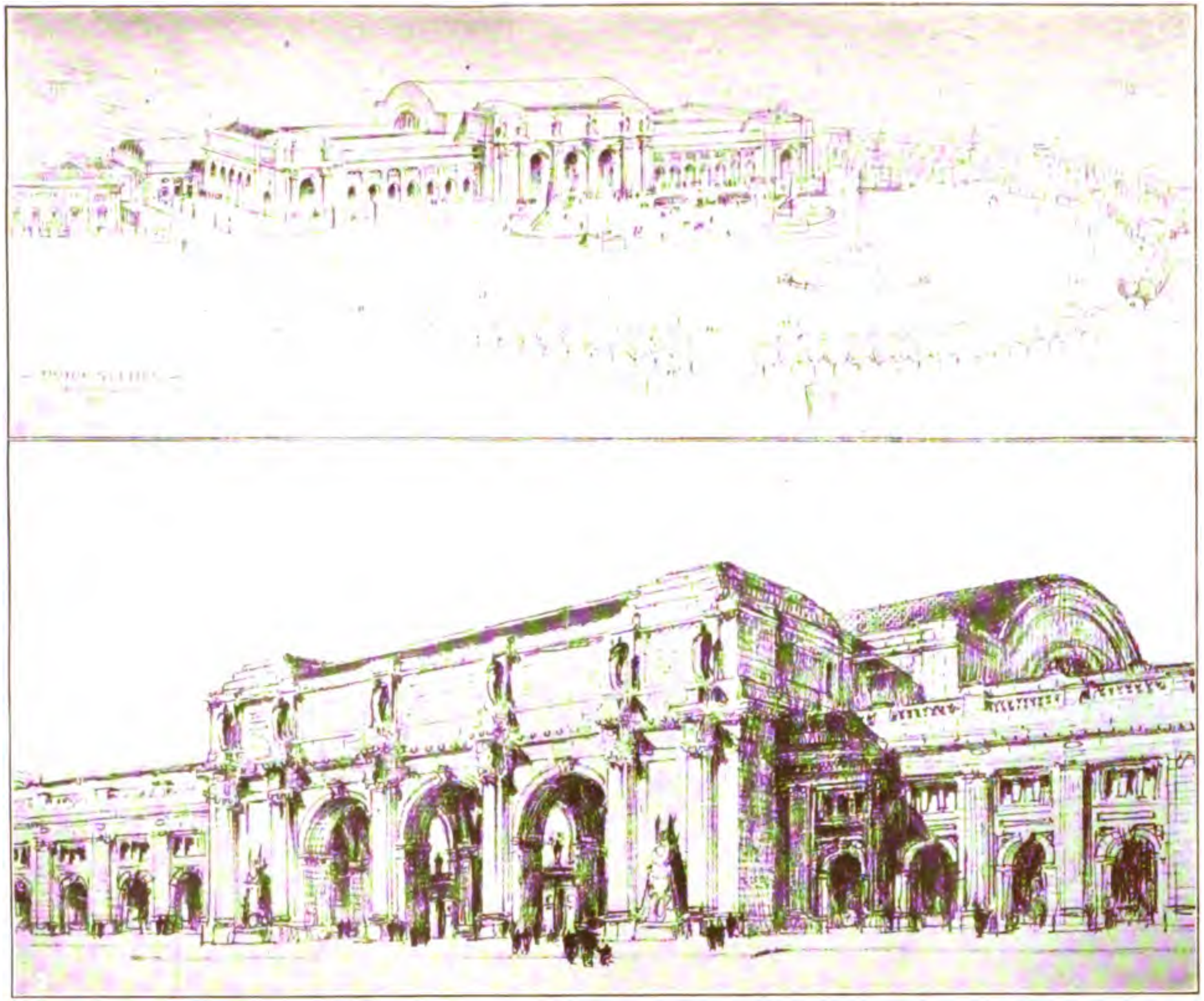

PERSPECTIVE VIEWS OF THE NEW UNION TERMINAL, WASHINGTON, D. C.

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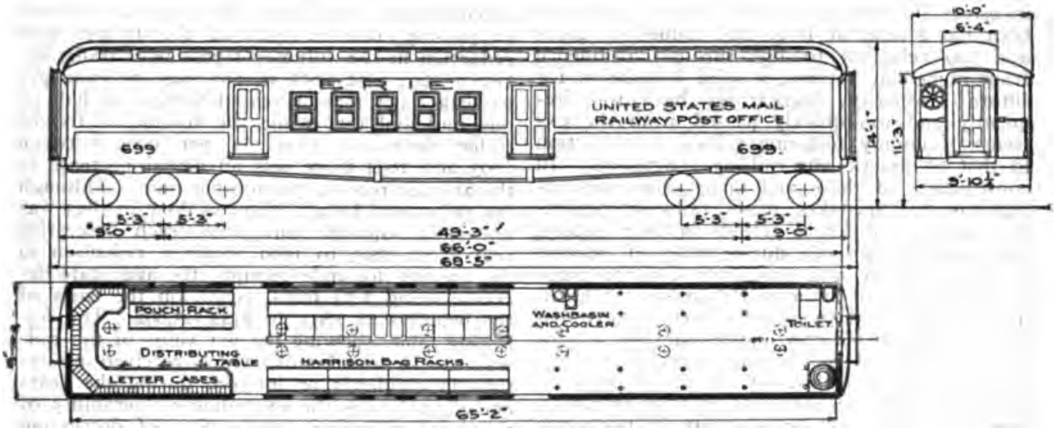
E. L. Corthell,
Civil Engineer, New York.

Railway Postal Cars, Steel. The all-steel postal car was first used by the Erie Railroad. The first of the type was built by the Standard Steel Car Company of Butler, Pa., and included in the exhibit of railway appliances incident to the International Railway Congress at Washington, 4-13 May 1905. It was also exhibited at Buffalo on 31 May 1905, at Cleveland on 2 June, and at Cincinnati on 5 June. The final exhibition was at Chicago on 7 June 1905, the car going into regular service that date on the Erie mail route between Chicago and New York. The car is 65 feet long and weighs 114,440 pounds, less than 15 ~~per cent. more than the 65~~ foot wooden postal car which weighs 101,700 pounds. The steel underframe is designed so that the weight principally rests on two center sills. These sills are 16 inches apart and are made of ⅜-inch steel plate, built up as a wedge shaped box girder, with a maximum depth of 22 inches in the center of the car and a minimum depth of 13 inches at each end. The framework of the body of the car is made of 5/16-inch steel plates, the roof of ⅛-inch steel plates, all riveted together as in boiler construction; the door and window frames being reinforced by heavy steel plating. The interior of car is lined on the sides, roofs, and ends with composition board ⅜-inches thick, with a ¾-inch layer of hair felt against the steel sides and 2-inch air space between hair felt and composition board. The floor of the car is of 5/16-inch steel plates securely riveted and built up as follows: At the bottom a wooden deafening floor ¾ inch thick is covered with a layer of hair felt above which is a 5-inch air space. Then is a layer of steel flooring which is covered with a cork and cement composition ¾-inch thick, and over this a thin maple wooden floor runs lengthwise with the car. In designing the car particular attention was paid to strengthening its ends, thereby obtaining the utmost resistance in case of collision.

The end sills are of pressed steel in channel form ⅜-inch thick, covered by ½-inch steel plates 12 ¼-inches wide to which the steel flooring is riveted. The end plate at the top of the car is of ¼-inch steel, 10 inches wide, in "L" shape with a 4-inch flange. The end uprights consist of two door posts, two end posts and two intermediates. All are made of angle iron securely riveted to the floor and roof. The end construction is therefore of extraordinary strength.

It was anticipated that the car would move noisily and be more difficult to heat in winter than the ordinary car, but these disadvantages have been largely overcome by the triple floors, the double lining, and the air space. The interior furniture conforms to that of the ordinary standard postal car, but all the woodwork has been covered with fireproofing. The steam heat is provided by the direct system, and there is also a Baker heater for emergency use. Nineteen acetylene gas lights from a plant furnished by the Commercial Acetylene Company aggregate a total of 712 candle power, in contrast with the 400 candle power of the ordinary postal car.



The steel postal car was the conception of Mr. F. D. Underwood, President of the Erie Railroad, and was adopted on that line to add to the safety of the United States mail agents and postal clerks whose runs are over the Erie Railroad. The steel car has, beyond question, a resistance so much greater than that of the wooden car that the danger of telescoping is practically eliminated, no matter how great the shock. The danger of fire is also eliminated in the case of the steel car, the interior being nearly and the exterior quite fireproof. Even under the most strenuous conditions of operation, an impact sufficient to buckle or crumple the steel postal car is almost beyond imagination. Even if a steel car were to buckle because of the great resistance, the crumpling would be slow and free from splinters and fire. The occupants could hardly be seriously injured, at least not from the causes which, in the wooden cars, are their greatest danger,—splinters, fire, and scalding steam from the locomotive.

That the steel postal car adds largely to the safety of the postal clerks, was thoroughly demonstrated in the accident to the Erie Railroad train No. 8, one mile west of Burbank, Ohio, on 23 July 1906. This steel postal car, number 699, was next the engine and the train was running about 45 miles an hour when the derailment occurred. The car rolled down a 20-foot embankment and turned over on its side, stopping about 30 feet from the track. No one of the three occupants was seriously injured, and the car received the roughest usage with practically no damage.

C. S. SIMS,
Assistant to President, Erie Railroad.

Railway Receiverships and Reorganizations. It would scarcely be expected that an industrial institution of such magnitude as the American railway system could develop within the comparatively short period since the year 1830 without some evidences of friction. The promoters of railway enterprises have not always thoroughly understood the conditions of the industry nor the commercial needs and possibilities of the regions served by their lines; investors in railway securities have sometimes been too greedy of large and immediate gains and too reluctant to lay, through abstinence from immediate returns, a solid foundation for future prosperity; legislatures have too frequently and too quickly passed from the extreme of unduly fostering railway construction to that of drastic anti-railway enactments. In consequence of these and many other misconceptions and mistakes many railway corporations have, at different periods in their history, been unable to provide during times of extreme business activity and prosperity for the regular recurrence of industrial depression. Earnings during good times have been wholly distributed among security-holders and no surplus accumulated for the period of relatively bad times certain to follow. Even the normal depreciation of the property has, in some instances, been underestimated or even utterly neglected, renewals and repairs have not been made or if made they have been charged to capital and not to expenses, where they belong. Such practices, supplemented in their evil consequences, by a good deal of positively vicious restrictive legislation, could lead to but one result, and that the bankruptcy of the corporations chiefly suffering from them. Indeed a study of the rapid changes in traffic conditions during successive years shows that even the wisest management might well have been perplexed as to how best to prepare for the exceedingly uncertain future. The statement at the foot of preceding column shows the aggregate transportation performed by the railways of the United States during each fiscal year from 1896 to 1909 inclusive, as measured in passenger miles and freight ton-miles.

TABLE SHOWING THE RAILWAY TRANSPORTATION FOR THE YEARS 1896 TO 1909 INCLUSIVE.

YEAR	Passenger miles — Number	Ton-miles — Number
1896	13,049,007,233	95,328,360,278
1897	12,256,939,647	95,139,022,225
1898	13,379,930,004	114,077,576,305
1899	14,591,327,613	123,667,257,153
1900	16,039,007,217	141,599,157,270
1901	17,353,588,444	147,077,136,040
1902	19,689,937,620	157,289,370,053
1903	20,915,763,881	173,221,278,993
1904	21,923,213,536	174,522,089,577
1905	23,800,149,436	186,463,109,510
1906	25,167,240,831	215,877,551,241
1907	27,718,554,030	236,601,390,103
1908	29,082,836,944	218,381,554,802
1909	29,109,322,589	218,802,986,939

It must be perfectly obvious that unless such heavy decreases in traffic as occurred after 1893 could be offset by advances in charges sufficient to prevent corresponding decreases in revenue and if they had not been forestalled by the accumulation of a surplus during more prosperous times, the consequences must involve reductions in the payments to security holders. This is precisely what occurred and in the case of those companies whose earnings during the more prosperous period had barely sufficed to meet interest charges, leaving nothing for dividends to stockholders, the reduced ability to pay interest on bonds frequently led to insolvency and the appointment of receivers. It should be observed, in passing, that in spite of the 15 per cent reduction in the volume of passenger traffic between 1894 and 1895 the average revenue per passenger per mile increased barely one half of one mill and that while the volume of freight traffic decreased over 14 per cent between 1893 and 1894 there was an actual decrease in the average receipts per ton per mile. Although the volume of freight business done in 1893 was not again equaled until 1898, each successive year from 1893 to 1899 shows a reduction in the average ton-mile receipts, the aggregate decrease being 1.54 mills, equal, on the basis of the business of 1893, to $144,125,692. The following table, showing the par value of the railway stocks and bonds, which received no return in dividends or interest, during the years named, indicates the exceeding vulnerability of railway corporations in the face of decreasing traffic and revenue;

YEAR	Stocks, receiving no dividends		Bonds,* receiving no interest	
	Par value	Per cent of total	Par value	Per cent of total
1889	$2,681,439,792	61.67	$775,851,795	18.19
1890	2,811,526,552	63.76	....	....
1891	2,654,258,391	59.64	473,925,526	9.90
1802	2,807,403,326	60.60	777,719,420	15.56
1893	2,859,334,572	61.24	743,015,132	14.39
1894	3,066,159,094	63.43	914,757,607	17.29
1895	3,475,640,203	70.06	890,561,460	16.71
1896	3,667,503,194	70.17	860,559,442	16.26
1897	3,761,092,277	70.10	862,950,840	16.59
1898	3,570,155,239	66.26	852,402,622	15.82
1899	3,275,509,181	59.39	572,410,746	10.45
1900	3,176,669,698	54.34	378,937,806	6.78
1901	2,828,991,025	48.73	361,905,203	6.23
1902	2,686,556,614	44.60	294,175,243	4.89

* Exclusive of equipment trust obligations.

When railway companies are unable to pay the interest on mortgage bonds it is the practice for the trustees under the mortgage, or other parties in interest, to apply to a court of competent jurisdiction for a receiver to manage the property in the interest of the bondholders. Such receiverships are not always unfriendly to the management in whose charge the corporation became insolvent. Indeed "friendly" receiverships instituted for the purpose of perpetuating the existing management and its policies in spite of its inability to pay interest, and to relieve the property of the burden of such payments in order that it need not be suffered unduly to deteriorate on account of the impossibility of meeting both interest and the cost of ordinary repairs and replacements out of revenue, have been frequent. So liberal has been the policy of some courts in this respect that the device of operation through receivers has even been found a convenient means of providing for the rehabilitation of properties that have been permitted to run down in order to keep up interest and, in some cases, dividend payments. The utility of this device is enhanced by the privilege, frequently allowed, of raising funds for repairs and even for necessary improvements by issuing "receiver's certificates," which are obligations having priority over everything except wages. The extent of the American railway mileage in the control of receivers has at times been appalling, but it is now very much reduced.

YEAR	Total mileage in the United States	In the control of receivers		
		Mileage	Per cent of total	Number of roads
1894......	178,709	40,819	22.84	192
1895......	180,657	37,856	20.95	169
1896......	182,777	30,475	16.67	151
1897......	184,428	18,862	10.23	128
1898......	186,396	12,745	6.84	94
1899......	189,295	9,853	5.21	71
1900......	193,346	4,178	2.26	52
1901......	197,237	2,497	1.27	45
1902......	202,472	1,475	.73	27

The preceding table shows the total railway mileage of the country, and the number of railways with their mileage, in the hands of receivers on 30 June of each year from 1894 to 1902, inclusive.

Nothing could be more significant of the increased prosperity of the American railway system, which has accompanied the general revival of business that has followed the depression of 1893–6, than the decrease shown by the foregoing, in the proportion of the railroad mileage of the country controlled by receivers from nearly one quarter of the whole in 1894 to less than three quarters of one per cent eight years thereafter. The release of railway property from the control of receivers is commonly accompanied by a "reorganization" or readjustment of its capitalization, and this may be secured with or without foreclosure. When reorganization is accomplished without a foreclosure of any of the mortgages standing against the property, it is by agreement among the owners of its various grades of securities. For the purpose of effecting a reorganization it is the practice to appoint committees representing the holders of the bonds or of the bonds and stocks, if it is thought practicable to permit the latter to participate in the reorganization. These committees devise reorganization plans which usually involve the surrender of some or all of the old securities and the acceptance in exchange of new securities bearing lower rates of interest or having a less absolute claim to regular returns or occasionally, of a lower aggregate par value. In several reorganizations the stockholders have been compelled to meet assessments on penalty of forfeiture of interest and in a few cases even owners of bonds have been assessed. When the holders of all grades of securities can be permitted to share in the reorganization and divergent interests can be reconciled so as to obtain an agreement, a foreclosure is unnecessary. It has frequently hap-

NUMBER OF RAILWAY CORPORATIONS IN HANDS OF RECEIVERS, 1883 TO 1910.

YEAR	Receivers appointed			Sold under foreclosure		
	Number of roads	Mileage	Par value of stocks and bonds	Number of roads	Mileage	Par value of stocks and bonds
1883..................	11	1,990	$108,470,000	18	1,354	$47,100,000
1884..................	37	11,038	714,755,000	15	710	23,504,000
1885..................	44	8,386	385,460,000	22	3,156	278,394,000
1886..................	13	1,799	70,346,000	45	7,687	374,109,000
1887..................	9	1,046	90,318,000	31	5,478	328,181,000
1888..................	22	3,270	186,814,000	19	1,596	64,555,000
1889..................	22	3,803	99,664,000	25	2,930	137,815,000
1890..................	26	2,963	105,007,000	29	3,825	182,495,000
1891..................	26	2,159	84,479,000	21	3,223	169,069,000
1892..................	36	10,508	357,692,000	28	1,922	95,898,000
1893..................	74	29,340	1,781,046,000	25	1,613	79,924,000
1894..................	38	7,025	395,791,000	42	5,643	318,999,000
1895..................	31	4,089	369,075,000	52	12,831	761,791,000
1896..................	34	5,441	275,597,000	58	13,730	1,150,377,000
1897..................	18	1,537	92,909,000	42	6,675	517,680,000
1898..................	18	2,069	138,701,000	47	6,054	252,910,000
1899..................	10	1,019	52,285,000	32	4,294	267,534,000
1900..................	16	1,165	78,234,000	24	3,477	190,374,000
1901..................	4	73	1,627,000	18	1,139	85,808,000
1902..................	5	278	5,835,000	18	693	39,885,000
1903..................	9	229	18,823,000	13	555	15,885,000
1904..................	8	744	36,069,000	13	524	28,266,000
1905..................	10	3,593	176,321,000	6	679	20,307,000
1906..................	6	204	55,042,000	8	262	10,400,000
1907..................	7	317	13,585,000	6	114	13,777,000
1908..................	24	8,009	596,359,000	3	138	2,547,000
1909..................	5	859	78,095,000	12	2,629	250,033,000
1910..................	7	735	51,427,500	17	1,100	93,660,109

pened, however, that the lower grades of securities have had to be excluded from participation, and in these cases their rights must be «foreclosed» by appropriate legal proceedings culminating in sale «under the hammer.» The statement on preceding page (compiled by the 'Railway Age') shows, for each of the years from 1876 to 1903, inclusive, the number of railway corporations for which receivers were appointed, with their mileage and the aggregate par value of their stocks and bonds. Similar data are also given concerning the railways sold at foreclosure sales.

While it is not probable that railway corporations will hereafter escape entirely from the misfortunes and mistakes which result inevitably in insolvency, it is gratifying to note evidences of greater wisdom in financial management and to record the impression which appears wholly justified by the facts, that the record of insolvency shown for the worst years of the last great depression will never again be equaled in the railroad field.

H. T. Newcomb,
Author of 'Railway Economics.'

Railway Rolling Stock. Between the earliest days in the history of railways when everything was in the most primitive condition, and the immense developments of traffic of recent years, there has been a steady progress while railroad students have applied themselves to the solution of the problem how the increasing traffic could be handled most expeditiously and at the same time economically. One of the most potent suggestions toward the reduction of working expenses is that the rolling stock shall have greater capacity in order to reduce the proportion of dead weight carried. As a result of this, rails have to be made heavier, roadbed more durable, and everything entering into railroad construction more costly. A freight carload not long since was 12 tons, while maximum carloads now reach, for certain commodities, such as coal, 60 to 100 tons, and from 40 to 60 tons for ordinary commercial freight. Locomotives have increased in weight from 50,000 pounds to 300,000 to 400,000 pounds, and the limit is not yet reached. We are taking up rails weighing 50 to 60 pounds to the yard and are putting down rails ranging from 80 to 100 pounds. We are getting away from bridges which were built to endure a live maximum load of 3,500 pounds per lineal foot, and are building bridges designed for live loads of 7,000 pounds and more per lineal foot, and as a consequence, couplings and drawbars have to be stronger and heavier.

Railroads are consuming constantly increasing tonnages of iron and steel in proportion to their mileage, and this tendency will surely continue until the highest factor of efficiency and consequently the lowest possible ton-mile cost of haulage is reached. It is not merely a matter of replacing rails and bridges, locomotives, and cars with heavier ones when the old ones are worn out, but it is more frequently a case of discarding the old for the new before the old equipment has seen half the years of its intended service. Freight cars cannot be made much longer or wider than the present maximum as long as existing curves have to be negotiated, but they may be made higher, because the almost universal use of the air brake no longer makes it necessary to allow for the brakeman between the car roof and the overhead bridge or viaduct. Their carrying capacity is also being augmented by the substitution of steel for wood.

Changing railroad conditions make it difficult to estimate the life of locomotives, and of passenger and freight cars. There are many passenger coaches in use to-day which were built 30 or more years ago and are still in good condition, if not modern in appearance. The cars that were lightly built 25 years ago have no business in modern heavy trains. On short branch roads they serve their purpose. The custom now is to build with steel underframing like the Pullmans, so that it is almost impossible to injure them in a wreck.

The box car's life is shortest of all rolling stock, and this is owing largely to the changes in construction. The capacity of cars has increased from 40,000 to 80,000 or 100,000 pounds each, and usage is rougher. The use of the air brake has helped to preserve them, but it is hard service at the best in the present-day long, heavy trains. There are many box cars running, however, which have seen more than 25 years of service, and their life might be averaged at 20 years. There is no reason why the steel gondolas should not last 30 years or more as there is less likelihood of their wearing out. When a box, freight, or passenger car serves its time, there is little to be scrapped. The trucks and rods are taken out and the wooden portion is burned or used for some purpose, such as toolhouses along the line.

Car equipment is not always discarded because worn out, but it may be out of style, or of too small capacity. One of the results constantly sought by railroad management is the reduction of hauling expense per ton per mile, and no road at this time thinks of a box car of less capacity than 60,000 pounds, and 80,000 or 100,000 is preferred. Monster locomotives and long trains of mammoth cars carry an immensely larger quantity of freight over the road in less time than formerly.

At a recent inventory it was found that there were in the service of the railways in the United States 44,871 locomotives classified as follows: Passenger, 10,870; freight, 25,944; switching, 8,057. The total number of cars of all classes was 1,803,389, assigned as follows: To the passenger service, 48,140 cars; to the freight service, 1,693,782 cars, the remaining 61,467 cars being those employed directly by the railways in their own service. Cars used by the railways that were owned by private companies and firms are not included in this statement. The average number of locomotives per 1,000 miles of line was 219. The average number of cars per 1,000 miles of line was 9,540. The number of passenger miles per passenger locomotive was 2,078,786. The number of ton miles per freight locomotive was 7,007,942. The aggregate number of locomotives and cars in the service of the railways was 1,848,260. Of this number 1,492,259 were fitted with train brakes, and 1,786,558 were fitted with automatic couplers. Practically all locomotives and cars in passenger service had train brakes, and of the 10,870 locomotives in that service 10,210 were fitted with automatic couplers. With respect to freight equipment most of the freight locomotives had train brakes, and 98 per cent. of them automatic couplers.

Locomotive building in the United States has reached that stage in its development when merely increasing the weight and size of locomotives for the railways to meet increasing weights of trains and severity of service does not suffice. It appears evident that to increase capacity, improve economy, and at the same time reduce injury to track a new development is needed. Already in Europe limits of size and weight in locomotives have been reached, and to meet analogous conditions in those countries the four-cylinder balanced compound locomotive has been developed into remarkably successful practice, especially in the principles of the de Glehn compound. To advance American practice by adapting to our conditions these principles, which have brought such advantageous results to European railways, is the object of the American Locomotive Company in its Cole four-cylinder balanced compound locomotive. It employs the principle of subdivided power; two of the cylinders (the high pressure between the frames) drive the forward or crank axle, and the others (the low pressure, outside of the frames) drive the second driving axle. In order to secure a good length for connecting rods without lengthening the boiler, the high-pressure cylinders are located in advance of their usual position. Special stress is laid on perfect balancing and the elimination of the usual unbalanced vertical component of the counter balance stresses, as a means for increasing capacity, improving economy of operation, and maintenance and promoting good condition of the track.

The question of properly loading locomotives has long since passed the theoretical stage, and it is now imperative to provide some practical and accurate method for obtaining the most economical results from operation. The putting of 125 per cent. on one train and 75 per cent. on another is not economical or in line with good practice, even though the average is 100 per cent. This condition exists on a majority of roads that do not provide for equating the tonnage of cars of different gross weight, and when engines are not properly rated. Some roads, when rating locomotives, take a given tonnage, say 2,000 gross tons, if in 65 cars, and the engine used its maximum power to haul it within the time allowed, that then becomes its rating. Now, when that same locomotive has 2,000 gross tons in 30, 40, or 50 cars, it is permitted to move over the road light loaded from 10 per cent. to 35 per cent., and in most cases is a net loss to the road so operating. It is impossible to build up all trains of equal average weight of cars; it is also impracticable to at all times place the heavy loads next to the engine, hence proper allowance must be made for each weight of car and its location in the train. The use of block signals has made it even more imperative that locomotives be not overloaded, for the reason that overloaded trains invariably stall on heavy grades, which, in turn, blocks trains following it on the same grade where they should have the benefit of momentum to assist them, but when stopped they frequently are unable to again get their train in motion, resulting in being obliged to double the hill, delaying themselves, and possibly trains of a superior class.

It is well understood that the punishment inflicted upon cars and lading by current conditions in handling heavy-capacity cars in long trains with modern locomotives is a source of heavy loss, both in actual expenditure of money to make repairs and pay damages and in time lost by cars out of service. The real cause of this trouble was not so clear, however, until a dynamometer car was provided, capable of measuring the shocks and strains incidental to handling modern traffic. The recent West Seneca tests are in themselves sufficient to show the magnitude of these strains and the total inadequacy of existing spring gear to protect them, while the great capacity of the Westinghouse friction gear and the peculiar nature of the resistance employed, which enables it to absorb and dissipate serious shocks, is well illustrated.

It will be conceded that, directly and indirectly, the most vulnerable feature in the brake equipment of to-day is the hose connection, due to the fact that while designed to be *uncoupled* as well as *coupled by hand,* it is the pernicious but inevitable practice to pull them apart, thus injuring and ultimately destroying the hose, not to mention damage done to piping and consequent loss by leakage. Reliable statistics show that the automatic air coupler reduces cost of air-brake hose maintenance more than 50 per cent., while the saving in time required in making up or shifting trains is very great. The beneficial effect of this saving in crowded yards can hardly be estimated. Another time-saving appliance which is rapidly coming into use is the automatic brake slack adjuster. The adjustment of piston travel by hand is at best a slow process, and the results are generally unsatisfactory from the standpoint of economy in the wear of brake shoes, while the inequality of piston travel resulting therefrom produces an unevenness of braking effect in handling trains that might well be avoided. The automatic adjuster is a cheap and efficient remedy for these troubles.

The use of electric locomotives is becoming more extensive. For many different varieties of service they present features of economy, convenience, and safety that are rapidly bringing them into general favor. For mine haulage, electricity is by far the most convenient, flexible, and economical form of motive power. For light service on short railroads, for suburban freight and passenger traffic, for yard and tunnel service, for industrial haulage, power-houses, lumber yards, and plantations, it possesses many important advantages over steam.

HUGH T. DOWNING,
Mechanical Engineer.

Railway Round-Houses. The development of the steam railroad engine-house or round-house, as it is more commonly called, is coincident with the development of the railroad. It was sufficient, in the earlier days, to provide a house more as a protection from the weather than as a shop fitted with studied appliances for quickly and economically making locomotive repairs and attending to the regular routine work. As the development of the railroad called for specialists in its various branches, the round-house demanded its share of careful engineering to obtain the desired result of having each installation and its accessories arranged to best suit the local conditions.

The general principles which govern the planning of a round-house lay-out are: proximity to the car-yards; unobstructed connecting tracks; independent incoming and outgoing tracks; facilities on either or both of these tracks for supplying the locomotive with coal, sand, and water; facilities on the incoming track for taking care of ashes and clinkers; storage-room for the maximum number of incoming engines; and cross-over or auxiliary tracks to allow flexibility in handling any one engine as received on the incoming track in preference to others or to minimize the chances of a blockade due to accidents.

Construction.—Most engine-houses are round, hence the commonly used term. Pivoted at the centre of the house and usually in an open pit is the turntable. In regions of heavy snowfall this pit is often covered. Radiating from this centre are the tracks which enter the stalls of the house and also the incoming and outgoing tracks. The inner and outer walls of the house are, in their relation to each other, concentric polygons, with their diameters coincident. The diameter of the house is large or small according to the number of stalls that are desired in the completed circle, the inner circle being proportioned so that the door openings will be wide enough to amply clear the widest locomotive. General practice is to make these doorways 12 feet wide and at least 16 feet high in the clear opening. The distance from the inner wall to the outer wall for new houses is seldom made less than 80 feet and in many cases much more. Figuring for the longest locomotive to be handled, a sufficient space is left between the walls of the building and the ends of the locomotive to pass around the house and do the necessary trucking.

There are several prominent instances where rectangular and other special shaped engine-houses have been constructed. This plan is adopted either as an expedient to use to the best advantage all of a valuable piece of property or to have the building fit harmoniously into the general arrangement of other shops around it. Instead of being served by a turntable these houses make use of a transfer table or a set of fan-shaped tracks. For turning the locomotives a "Y" or a turntable is added.

In arranging the stalls of a round-house, care is taken to have opposite tracks match across the table. This little detail is of the greatest benefit in the operation of the house because it permits the handling of a dead locomotive by other locomotives under steam. If the tracks do not match, this cannot be done and much time is lost in moving the engine by hand.

Some sort of power device is generally used for turning the table. Electricity, compressed air, steam, and gasoline are employed according to the local conditions. When electric current can be depended upon at all hours of the day and night it is usually selected. Gasoline engines are preferable when an independent equipment is necessary. Compressed air and steam can be used to advantage but they are not as satisfactory.

Situated between the rails of the tracks in the house are the pits. These pits are for use in getting at all parts of the running gear of the locomotive. They are made long enough to extend beyond the front wheels of the engine and the rear wheels of the tender. The usual length is from 50 to 60 feet, with the bottom sloping toward one end, in either direction, as best suits the drainage problem. The depth varies considerably, a fair average, however, is 30 inches at the shallow end and 36 inches at the deeper end. The pit floor is crowned in the centre, thus leaving a place as dry as possible for the men to stand on while under the locomotive.

A very important detail, from the operating standpoint, is the flooring of the house. This must be very substantial as well as impervious to water and oil, both of which are always present in large quantities. Experiments are being extensively carried on to determine what is the best floor to use, from which it appears that some form of concrete is the most satisfactory. Brick and cedar blocks as well as planking are also used extensively. The floor is arranged to shed the water as quickly as possible into the pits.

The heaviest service on the floor comes just outside the pits where lifting and jacking is done around the locomotive. With a view to strengthening this floor the sidewalks of the pits are sometimes made very wide so that the jacking can be done directly over them. Good heavy timber construction for this part of the floor is very serviceable.

Pipe outlets are arranged around the house so as to deliver compressed air, steam, and water to the spaces between the pits. The air and steam mains are ordinarily placed overhead with drop pipes for the outlets. At times, however, these mains are located in the same underground pit which contains the water mains. The pressure in the water main is maintained at least at 100 pounds per square inch. This pressure is utilized in washing out or cleaning the locomotive boilers of the mud and scale present, at times in large quantities.

Some sort of blow-off piping is ordinarily installed. The simplest plan is a main pipe connecting all the pits, from which there is a branch to each pit with a check and special fitting for connecting it to the boiler of the locomotives. The main pipe has an outlet through suitable catch basins and traps to the sewer.

In connection with the washing out of boilers, there are many more or less elaborate arrangements of pipes and reservoirs used, which have for their aim the saving of water and the conservation of the heat ordinarily wasted in the blow-off water.

The heating, lighting, and ventilating of engine-houses are problems which until recently have been only partially solved. Newer houses are constructed with the walls made, as far as practicable, of glass. The doors and even the roofs are also arranged to admit light. For night use, electric lighting is used, where possible. With a generous supply of plug outlets and extension lights, a model condition is obtained. The unsatisfactory oil torch and lantern are thus eliminated.

The heating and ventilating problems are being very successfully solved by the "hot blast" method of heating. This is the well known system of forcing heated air through ducts which distribute it advantageously throughout the building. For round-house use the particular advantages are in being able to concentrate a larger or smaller amount of hot air, as desired, upon the icy or frozen machinery of a locomotive and in supplying a large quantity of fresh air, continuously forcing out the gaseous and vitiated air produced by the fires in the locomotive boilers.

Machine Tool Equipment.— Very few round-houses of any importance are in operation which do not have some sort of machine tool equipment. The list contains, generally, a large and a small lathe, a planer, a shaper, a drill press, a bolt cutter, and an emery wheel. In case the house is not in touch with some repair shop, additional machines are installed, such as an air compressor, a dynamo, a wheel press, a wheel lathe, and drop pits. These, together with an assortment of air tools and the many special handy tools, permit of the heaviest running repair work being done on the locomotives.

Outside Facilities.— The outside facilities in connection with the round-house consist of the coaling station, the sanding appliances, the clinker pit, and the watering arrangements. These are ordinarily located on the incoming track between the storage track and the turntable. Their arrangement is varied to suit local conditions but, as far as possible, the clinker pit is placed close to the turntable. After the fire is removed from the grates it is very injurious to the boiler to handle the locomotive more than absolutely necessary, hence the clinker pit is located with this in view. The pit is some form of opening under the rails of the track into which the clinkers and ashes can be dropped. From the pit they are removed to the cinder cars for disposition along the company's right of way. A small pit is sometimes provided under the outgoing track for the cleaning of the ash pans of locomotives that are leaving the house.

Water is obtained directly from a tank by means of a drop spout or from a swinging stand pipe. Where conditions permit, this tank or pipe is located in connection with the sanding apparatus so that the locomotives can be supplied with one movement. The sand is supplied by gravity through a suitable pipe from an elevated storage bin. Before being stored it is dried or roasted so as to remove all traces of moisture.

The coaling station consists of some sort of elevated bin and a suitable spout to deliver the coal to the locomotive tender. Various types of coal chutes, as they are called, are used. A familiar form is the inclined track chute up which the loaded cars are pushed by a locomotive or hauled by a cable. The top of the chute where the cars are to stand is made level. The coal is removed into storage pockets. According to the type of chute, these are made large enough to hold several hundred tons of coal or small enough to hold a supply of coal sufficient for one locomotive.

In some installations, a combined coal chute, clinker pit, and sand tower is used. For this plan, a conveyer takes the coal from a pit under the coal supply track and deposits it in a hopper over the engine track. This hopper is supported on scales and autographic records are made of the coal delivered to the locomotives. This same conveyor also takes the ashes from the clinker pit to a storage bin from which they are delivered to cars. The sand also is elevated to its special bin. With suitably located water supply this sort of installation is very economical of space. It also permits of the giving of all supplies as well as cleaning the fire with one "spotting" of the locomotive.

To take the place of a coal chute and a depressed cinder car track, locomotive cranes are often employed which are arranged with grab buckets. These cranes can take coal directly from the car and deposit it into the locomotive tender as well as pick up the ashes from the clinker pit and deposit them in the cinder car.

Organization.—A round-house is a scene of activity for all of the 24 hours of the day. The continued arrival and departure of locomotives, together with the routine work of repair and attention given them, requires an organization which must run with clock-like precision and at the same time must be capable of adjustment to abnormal conditions.

At the head of this organization is the round-house foreman, who is responsible to the division master mechanic. He also works in conjunction with the train dispatcher, having in view the getting of certain locomotives ready for service at the proper time for regular trains and others as soon as possible for extra trains. His particular duties are to distribute the work to the workmen and keep in touch with all that is going on in his domain. When the house is large and the amount of detail too great for the personal attention of one man, sub-foremen are appointed to have charge of such special work as machine repairs, boiler washing and inspection, engine dispatching, etc. These men take complete charge of the details assigned them and report to the house foreman.

The engine-men, on bringing the locomotive from the yards or station, leave it on the storage portion of the incoming track. The engineer looks over the entire machine, inspecting each part for defects and then makes a written report on a prepared form of what he finds wrong. He adds information concerning the boiler pops or safety valves, the injectors, the air pump, and other such special fittings.

The fireman attends to obtaining the necessary supplies, such as oil, waste, etc. It is customary in most instances for the engineer to leave a ticket for the amount of coal the hostler is to take on the tank. After leaving the locomotive the engineer registers in; that is, he fills out the register. Here he writes his own name, his fireman's name, his engine number, the train number, the time of arrival at the round-house, and all such train-operating information. Often he is required to show the hours that he has been on duty and the amount of rest that he is entitled to before he can be called for service.

The locomotive is taken from the storage track by the hostler and his helper to the coal chute, the sand tower, the water tank, and the cinder pit. The supplies are obtained and the fire cleaned before taking it across the turntable to the house. After reaching the stall, a second inspection of the machinery is made by a man trained to that special work. This man also makes a written report and the two records thus obtained must tally in important details. These work reports are used by the foreman or his assistant in distributing the work among the mechanics.

A boiler maker enters the fire box and inspects and makes running repairs to the boiler, especially stopping all leaks as they are found in the flues and fire box. The smoke box at the front of the boiler is regularly opened and examined for defects in the spark-preventing devices.

At certain times, the periods varying according to the local water conditions, the locomotive boiler has to be washed out or have the water changed. If the latter course is pursued, the water is allowed to run out and the boiler filled with a fresh supply. If washing is done, the various washout plugs are removed and all the internal parts of the boiler thoroughly washed off. This is accomplished by the use of special nozzles of various sorts which will throw the high-pressure washout water to just the points desired.

Each mechanic, as his part of the work is finished, makes his «completed» mark on the engine condition board or on the locomotive itself. By reference to the board the foreman and the call boy can tell at a glance what locomotives are ready for service and approximately how soon others will be ready. As soon as definite information can be given as to the time that a «rounds» locomotive will be ready, the train dispatcher is notified. On his order, the engine-men are called and the locomotive sent to the yards.

Engine-men regularly assigned to certain trains are expected to be on hand in time to look over the locomotive, inspect all parts, see that all the necessary supplies are on hand, and take the locomotive either from the round-house stall or the outgoing track. If the train is unusually late the call boy is sent to advise them of the fact. The calling district is ordinarily within a radius of one mile of the house. Men on «rounds» engines or extra men, as they are designated, are always called. They are supposed to remain within the calling district and to advise the round-house foreman of their whereabouts. When called, the men are usually required to put their signature in the call book which the boy carries with him, and occasionally to add the time. Some organizations require a registering out as well as the registering in.

W. E. DUNHAM,
Mechanical Engineer, Chicago & North Western Railway Co.

Railway Securities. The capital required for even a relatively small railway is usually far beyond the amount which could be supplied by even the wealthiest individual or the largest group of individuals which could be satisfactorily included in a partnership. The legal device of incorporation is probably the only means so adapted to the requirements of railway finance as to provide the sort of capitalistic association necessary to the enormous railway development of the last 70 years. It meets not only the need for vast aggregates of capital, but also those for limited liability, centralized control and substantial continuity of management and policy. Consequently those who undertake railway enterprises invariably receive corporate securities in exchange for their contributions of capital and these, representing claims upon the property created and its earnings, are properly regarded as constituting liabilities of the corporation. In the simplest form of financing a corporate enterprise the securities issued are all of one grade and participate equally in the distribution of the profits while having no other claim upon the assets of the corporation unless it is dissolved and its affairs wound up. Such securities are known as stock or shares of stock. In practice it has been found advisable to hold out different inducements to different classes of investors. Some investors are attracted by speculative proposals in which the possible gains are high, but the event doubtful, while others prefer lower returns if they are accompanied by greater certainty. The more conservative investors are therefore offered, according to their respective degrees of conservatism, preferred stock, non-cumulative or cumulative; income bonds; collateral trust bonds, equipment trust bonds, and mortgage bonds. Preferred stock is entitled to dividends at a certain rate before there is any payment to the holders of common stock and if it is cumulative the dividends not earned or paid during a particular year must be made up before there can be any dividend payments on the common stock. Preferred stock may or may not participate in further earnings beyond the rate for which it is preferred. Income bonds entitle the holder to a certain interest, provided it is earned. Collateral trust bonds usually rest upon the credit of the company issuing them and also represent pledged securities, commonly those of subsidiary corporations. Equipment bonds are issued to provide for the purchase price of new equipment, commonly paid for in annual or semi-annual instalments, and are secured by a lien upon such equipment. Mortgage bonds, as their name implies, represent indebtedness secured by mortgage upon all or part of the property of the corporation. Many railways have outstanding several classes of mortgage bonds of different degrees of priority. The following statement shows the par value of the securities of the different classes outstanding on 30 June 1909 and the proportion of each class to the aggregate representing all securities:

	Par value
Common stock	$6,218,382,485
Preferred stock	1,467,896,060
Miscellaneous obligations	2,267,211,732
Income bonds	284,497,531
Equipment bonds	307,869,061
Mortgage bonds	6,942,012,066
Total	$17,487,868,935

It is important that the total par value of the securities shown above should not be mistaken for the actual capitalization of railway property. It is considerably in excess of the real capitalization, that is, the securities in the hands of the real owners (and creditors) of the railways, for railway corporations are themselves large owners of railway securities. The controlling corporations in large systems often own large blocks of the stocks and bonds of subsidiary corporations for which, in turn, they have issued their own shares or bonds. Consequently there is much duplication which must be deducted before the real capitalization, so far as the public is concerned, can be discovered. The railway shares held by railway corporations on 30 June 1902 had a par value of $1,710,145,344 and the bonds so owned had a par value of $498,373,449.

Deducting the total of these amounts, $2,208,518,793, from $12,134,182,964, leaves $9,925,664,171, as the par value of the railway securities actually outstanding as against the railway system as a whole. It is interesting to observe that the total payment to the owners of these securities during the year which ended with 30 June 1902, was $417,511,227, an amount which if capitalized at 4 per cent per annum would equal $10,437,780,675 or within 5.16 per cent of the actual capitalization.

H. T. Newcomb,
Author of 'Railway Economics.'

Railway Shop Practice. Railway shop practice differs in many respects from methods in effect in the average manufacturing concern. This is especially true of the class and character of the work performed. In private institutions where the product consists largely if not entirely of new work, a single operation may be repeated over and over again. A factory making a specialty of the manufacture of bolts may construct a machine and supply it with a full equipment of dies to produce a certain size of bolt. The machine can then be operated up to its maximum capacity on this single product until it is worn to a point where it is rendered unfit for further service.

A locomotive plant, manufacturing new engines only, may so classify the work as to be able in almost every instance to confine the entire time of each machine to repeating a certain operation.

In the locomotive repair shop, however, on account of the wide range in the number of pieces and the small capacity of the average shop, such a variety of operations is required as to render necessary the accomplishment of many kinds of work on a single machine.

A 90-inch boring mill must be used to bore driving wheel tires, turn, bore and face cast iron and cast steel wheel centres, face locomotive front ends, turn and bore cylinder bushings, and so on. In like manner, a 42-inch boring mill will be required to bore eccentric straps, turn and bore eccentrics, face cylinder heads, turn, bore, and cut off cylinder and piston valve packing, and many other operations which in each case require special tools for setting and machining the work. One bolt machine will likely be used to head, and one thread cutting machine to thread all the different sizes of bolts for the plant.

Therefore, on account of the variety of the work to be considered, the scope of this article will cover certain rules, which, if carefully followed, should secure the maximum output of such average shop facilities as are to be found at present in connection with the various roads of the country.

The capacity of any shop depends as much or more on its official organization as upon the number of men employed. The discipline maintained in the shop during working hours and the relation of the foremen one to another are among the first subjects that will confront the shop superintendent, and which must be studied and mastered by him before he can hope to obtain results from the equipment and force in his charge.

Every railway repair shop is divided into certain departments, among which may be enumerated the erecting shop, or floor side; the machine side, including the fitting shop, or vise work, and the tool room; the tin, pipe, and copper department; the blacksmith shop, boiler shop, paint shop, tank and truck shop, and carpenter shop. Under certain conditions there might be others, as the foundry, frog shop, etc., but this class of work will not be considered here. Each one of these departments should have an official head, and over all must rest the guiding hand of the master mechanic or shop superintendent.

A successful shop organization must be equal in all its parts, and the head of each department must be a manager of men as well as an observer of details. If the foreman in charge of a certain class of work is incompetent, inactive, or deficient in methods of discipline, or if he lacks a particular machine or device for quickly handling his part of the repairs, the output of the plant, no matter how well equipped every other department may be, will finally be measured by the number of engines which he is able to repair in a given time.

When capable men have been placed at the head of each department, the shop superintendent should then sustain them to the extent of his ability, holding them individually responsible for their duty to the company and their relation to the men.

The qualifications necessary to make up a well-rounded foreman are good health, judgment or common sense, honesty, determination, tact, energy, special knowledge of the work, and a fair education; and with his agencies, men and machines, he should work for results. He must plan his work ahead and see that each machine over which he has charge is supplied with the proper clamps, jigs, and appliances for doing the work, as well as proper cutting tools, and are used to set the work in the machine and cut the metal at the right speed and feed. This requires ability to take pains with little things and concentrate the necessary forces on a multitude of small things. Each machine must be kept clean and in good order, and to do this the foreman must be clean and neat himself.

The successful gang foreman must have executive ability which is nothing more or less than knowing how to distribute responsibility so that every workman not only accepts his share of duty, but continues unfailingly to do it. If he accomplishes results, he must know how to make other people feel the trust imposed upon them, and to faithfully perform the part of work assigned to their charge. Every man in the shop must be held responsible for his work, which should be the required amount and of the proper quality, not because the foreman watches him closely, but rather from a pressure of a right conception of his duty to the company which should make itself felt throughout the entire shop.

Gang foremen, so far as it is possible, should be relieved practically of all clerical work. Their time should be spent with the men in teaching them quick methods and looking after such details as have a direct bearing on the output.

A constant supervision should be kept over the work of each department to see that it is quickly moved from one shop to another, or from one machine to another, and to see that each operation is being done according to the best known methods or on the machine best adapted to that particular work.

The sole object to be sought, both by men and foremen, must be the greatest possible output of perfect finished work with the least delay and waste.

To accomplish this, the particular line of work in charge of each foreman must be systematized. There must be a certain routine way of doing things, and that the best way.

This one thing should be remembered, however, that system is not work, but a means of reducing the amount of labor necessary to produce a fixed product; system requires no specialists, but permits few to accomplish much by bringing brain and hand into intelligent action. It loads no man with labor beyond his proper share, but lightens the task of each by exactly defining it. The heavy load usually borne by a few faithful employees is distributed evenly upon all. Hard work always begins where system and the application of intelligent methods ends.

The Machine Shop.—The capacity of any locomotive repair shop depends largely, if not entirely, on the number and kind of its machines, but the introduction of the so-called high speed steels has had much to do lately with increasing the output of this department. The new steels have worked a revolution among machine builders generally; the old time lathes, boring mills, drill presses, planers, etc., are found to be entirely too weak to stand the great strain necessary to drive the new steel to its maximum capacity. The history of this comparatively new product had its origin in the introduction of the Taylor-White process of treating tool steel in the works of the Bethlehem Steel Company, in 1900. Hundreds of experiments were made by these two gentlemen, which finally resulted in producing a steel which is capable of producing in a given time two or three times as much work as any of the old carbon steels.

Another very gratifying result of these experiments is that they have awakened the management of railway repair shops, and the amount of work that can be done, even on the old machines, is a revelation to the entire mechanical world.

There are several brands of this steel, those in general use being Mushet's Special, and Allen high speed steel, which is an English product; Styrian or Bohler rapid steel, an Austrian product; Midvale, Novo, Rex, Zenith, etc. While some of these steels may be capable of greater endurance than others, any of them, under proper treatment, will be found superior in strength to any of the machines now in use, except those recently built. In using the high speed steel, however, it is not advisable to have too many different kinds in the same plant.

If the tool dresser is thoroughly familiar with one or two grades of high speed steel, and the quality is of such character as to produce results which will insure the maximum capacity of the machine, better results will be obtained by the adoption of these grades to be used in standard practice. No two high speed steels can be dressed and tempered exactly alike if the maximum output is desired, and if the tool dresser understands treating one of the standard grades correctly, the adoption of this make of steel will mean much time and money saved with better and more satisfactory results in the shop.

When these high speed tools are properly dressed and tempered, if it happens that the cutting edge is work, chipped, or crumbled away by very heavy feeds or speeds, after they are put into the machine the mistake of sending them back to the tool dresser should not be made if they can possibly be ground in the space of five or ten minutes, because if care is taken not to overheat them in grinding, they will be found to give much better results than when re-ground.

Some differences of opinion have existed, and perhaps always will, as to the proper feeds and speeds which should be maintained on the different metals, and no fixed rule can be laid down which will meet the requirements of all shops. The work varies somewhat in different shops. There is more or less difference in the construction of the parts.

The amount of metal to be removed and the accuracy of the work are also factors in determining proper feeds and speeds; but the fol-

A. B. C. Railroad Company

Shop ______________________ Date ______________________

Description of Operation and Material: Boring 60-inch driving wheel tires.

Machine: 90-inch boring mill.

Tire No.	Size of Tool.	Depth of cut.	Feed.	Speed per min.	Time started.	Time finished.	Duration of tool.	Remarks.
1	1-1/4 by	1/10"	5/32"	30'-8"	3.37 P	4.01 P	24 M	Tool in good condition,
2	1-1/4	3/32"	"	"	4.39 P	5.04 P	25 M	" "
3	"	"	"	"	7.03 A	7.28 A	25 M	" "
4	"	1/10"	"	"	8.12 A	8.38 A	26 M	Tool in fair condition.
5	"	"	"	"	10.12 A	10.30 A	27 M	" "
6	"	3/32"	"	"	11.12 A	11.38 A	26 M	Nose of tool gone.
7	"	1/16"	1/4"	34'-0"	8.57 A	9.08 A	11 M	Tool in good condition
8	"	"	"	"	9.40 A	9.51 A	11 M	" "
9	"	"	"	"	10.25 A	10.37 A	12 M	" "
10	"	"	"	"	11.00 A	11.13 A	13 M	Tool in fair condition.
11	"	"	"	"	11.40 A	11.50 A	10 M	" "
12	"	"	"	"	1.20 P	1.35 P	15 M	" "
13	"	"	"	"	2.05 P	2.20 P	15 M	Tool ground.
14	"	1/8"	"	23'-0"	8.44 A	8.58 A	14 M	Tool in good condition.
15	"	"	"	"	9.39 A	9.51 A	14 M	" "
16	"	"	"	"	10.23 A	10.38 A	15 M	" "

lowing table taken from the records of an average railway repair shop shows what should be done in the way of speeds and feeds on a machine of ordinary capacity. An average grade of high speed steel was used, and the condition of the tools shown at the end of each operation, is a fair representation of what should be accomplished in any shop with like tools and under similar conditions.

The preceding table shows the machine operation only. The time necessary to set the work will, of course, be determined largely by the facilities at hand for that purpose. With the exception of driving and truck wheel tires, cast steel wheel centres, and similar material, the following speeds can be maintained in roughing out work. A somewhat higher rate of speed may be used on finish cuts: Wrought iron and soft steel, 40 to 60 feet; cast iron, 60 to 80 feet; tool steel, 20 to 40 feet; brass, 120 to 180 feet.

These speeds, of course, may be affected both by the shape of the tool and the quality of the material. For long, continuous cuts on very hard cast iron, the speed should be reduced. Locomotive steel driving axles, rough forged, should be reduced to size ready for finish cut at a speed of 60 feet per minute, with ⅜-inch cut and ¼-inch feed. Locomotive driving wheels, 44 inches to 84 inches in diameter, may be turned at a speed of 15 to 18 feet per minute, with ½ to ⅝-inch reduction and ⅛ to 3/16-inch feed. On the modern 50 horse-power 90-inch lathe these wheels should be turned out at the rate of five pairs in ten hours. A cylinder packing drum 18 to 24 inches in diameter and of sufficient length to make at least 12 rings should be set up and roughed out on a modern boring mill in about one hour. The finish cut should be taken with a broad-nose tool in about five minutes, including time to change tool. Piston rods, rough forged, should be roughed at a speed of from 60 to 80 feet per minute with 3/16-inch feed and ⅛-inch to ¼-inch depth of cut. Cast steel engineframes should be planed at a speed of 20 to 30 feet per minute with a ¼-inch cut, ½-inch feed.

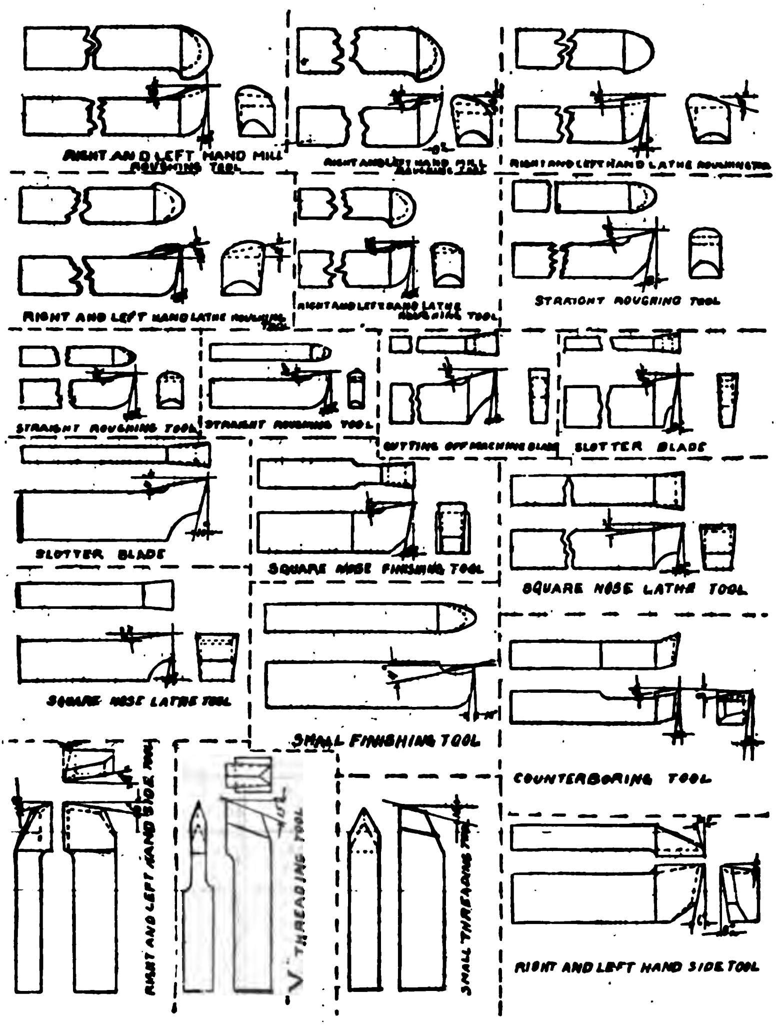
These speeds and feeds can only be maintained on modern tools. On machines which have been in use for some time the speed and feed should be reduced to meet the conditions.

Planers.—Planers using high speed tools should maintain the following cutting speeds with a return per minute of about two to one.

20 x 20, speed travel of cut 40 to 48 ft. per min.
24 x 24, " " " " 36 to 40 " " " .
36 x 36, " " " " 32 to 36 " " "
48 x 48, " " " " 28 to 32 " " "

If planers are powerful enough to pull the cut, the above speeds should work on wrought iron and soft steel as well as cast iron.

Lathe and Similar Cutting Tools.—The following sketches show what, in general practice, have been found to be the best shapes of cutting tools used in the principal operations of repair work:


RIGHT AND LEFT HAND MILL ROUGHING TOOL
RIGHT AND LEFT HAND MILL ROUGHING TOOL
RIGHT AND LEFT HAND LATHE ROUGHING TOOL
RIGHT AND LEFT HAND LATHE ROUGHING TOOL
RIGHT AND LEFT HAND LATHE ROUGHING TOOL
STRAIGHT ROUGHING TOOL
STRAIGHT ROUGHING TOOL
STRAIGHT ROUGHING TOOL
CUTTING OFF MACHINE BLADE
SLOTTER BLADE
SLOTTER BLADE
SQUARE NOSE FINISHING TOOL
SQUARE NOSE LATHE TOOL
SQUARE NOSE LATHE TOOL
SMALL FINISHING TOOL
COUNTERBORING TOOL
RIGHT AND LEFT HAND SIDE TOOL
V THREADING TOOL
SMALL THREADING TOOL
RIGHT AND LEFT HAND SIDE TOOL

The cutting qualities of a tool are governed largely by the shape of the cutting point or cutting edge. The principal conditions governing the shape of the tool are the kind of metal to be cut; the hardness of the metal; rough or finish cut; and manner in which tool is presented to the work.

For soft material, such as mild steel and wrought iron, the angles may be made much keener than when cutting harder metals. On materials that have a tendency to draw the tool in, as copper or brass, the angles may be made very blunt, often a negative take is given them. Tools for cutting soft iron and steel should be ground with sufficient keenness to turn long, curled shavings. The shaving is a good index with reference to the correct shape of the tool. When the shavings roll up in long curls, it is a very good indication that the tool is correctly ground and properly set in the tool post for the work; but if the shavings are crumbled and broken into small pieces, it indicates that the tool is improperly ground, or not correctly set to the work.

Either one or both conditions may be wrong. Tools used in taking heavy-roughing cuts should be given top rake sufficient to give a keen cutting edge the full depth of the cut taken.

In finishing cuts the amount of metal is not great, and most of the cutting is done with the point of the tool, in which case the top rake should be reduced. The position of the tool in the post will have much to do with the rake. For instance, the angle of top rake may be changed from front top rake to side top rake by changing the position of the tool as it is presented to the work.

If the tool is set with the point in advance of the tool post, care must be taken to see that it is firmly held, because if it becomes loose, it will "dig in" and is likely to spoil the work. If the tool post is set in advance of the point of the tool, there is little danger of serious results, should the tool become loose, as it will swing away from the work.

Tools for cutting iron and steel should be set as high as possible on the work, and always above the centre, while for brass it is best to grind the tool without any top rake and set it on the centre or slightly below the centre.

Cutting tools for machine operations, whether turning or boring, should be ground so that their rake or top angle will be sharp to the heaviest part of the chip. For instance, if a tool is to be used for facing the hub of a wheel, the part of the tool which first comes in contact with the iron should be a sharp angle, so that the heaviest part of the chip will flow easily away, while that part of the tool that leaves its mark on the finished face will take a shearing cut or angular shaping cut, and leave a smooth surface.

There is no more important point to be borne in mind by any one wishing to know how to obtain the best work from a machine than the cutting angles of the tools. In a general way every one knows that a tool should have as little clearance and as much top rake as consistent with the wear of the tool, but the man that makes the greatest record is the one that puts it into practice.

The next point is that no tool should be allowed to project beyond the holder or support more than is absolutely necessary. After the tools have been ground and set properly, they should have a chip or feed course enough to keep them from losing the edge in the vain employment of making thin chips — for if the chips are very fine it means that the tool has not only removed the metal but cut it into fine chips of no special value. Weak lathes generally do better work with a medium feed than a fine feed. A very fine feed is often used in trying to turn an extra true piece of work, with the result that the tool does not leave an even surface. It alternately "digs in" and "backs out" with a fine feed, when a medium feed would have resulted in an even steady cut.

Chattering frequently occurs because the chip or cut is not large enough to hold all the slack of the springing parts. More feed is usually the cure for chattering. Of course, chattering may be caused by a cut that is just heavy enough to balance the weight of the work and spindle, and then the slight necessary looseness of spindle bearings gives the chance for chattering. An old-fashioned remedy for this is to turn the tool upside down to get the pressure down on the work.

Chattering is destructive to the sharp edge of the tool and should be stopped as soon as noticed; but do not think a lighter cut is necessary, for frequently a heavier cut stops the chattering.

Facing cuts should be taken by tools with round shanks, for these can be turned so as to give the desired rake for free cutting.

In facing a piece in which the diameter of the cut in one place is two or three times its smallest diameter, make sure to take advantage of the change in speeds, for a very important reduction in time of operation as well as the durability of the tool may be effected by these changes.

Twist Drills.—The following table shows the revolutions per minute, and also the feed per revolution at which high speed twist drills can be run with safety. The revolutions mentioned are intended for wrought iron and steel and also for cast iron. On cast iron, however, it

HIGH SPEED DRILLS			CARBON DRILLS		
Size of drill.	R. P. M.	Speed Per Rev.	Size of drill.	R. P. M.	Speed Per Rev.
1/4 inch	1050	.008	1/4 inch	450	.005
3/8 "	700	.011	3/8 "	300	.005
1/2 "	500	.016	1/2 "	210	.007
5/8 "	420	.016	5/8 "	160	.007
3/4 "	350	.016	3/4 "	140	.010
7/8 "	300	.016	7/8 "	130	.010
1 "	260	.020	1 "	110	.010
1-1/8 "	230	.020	1-1/8 "	100	.010
1-1/4 "	210	.020	1-1/4 "	90	.015
1-1/2 "	180	.020	1-1/2 "	75	.015

will usually be possible, unless the metal is very hard, to exceed these speeds 20 to 25 per cent; and on brass the speeds may in most cases be doubled without injury to the drill. On the right will also be found a table of the speeds and feeds of carbon drills.

Carbon drills should seldom exceed 28 to 35 feet per minute on iron and steel and 60 feet on brass, measured on the circumference of the drill, and a feed per revolution of .004 to .007 for drill 3/8" and under in diameter. At these speeds and feeds it will be necessary to use plenty of oil or a solution of drilling compound when drilling steel, wrought, or malleable iron. It will also be found advisable to vary the speed somewhat according as the material to be drilled is more or less refractory.

High-speed drills may be run at a safe speed of 60 to 80 feet per minute on steel and iron, while no oil or drilling solution is required.

It has usually been considered good practice to grind the cutting edge of twist drills at an angle of 59 degrees, but recent experiments made with high-speed steel prove conclusively that an angle of 45 degrees will give equally good results with much less thrust on the drill. The following table shows the results of experiments along this line:

Angle of drill.......	37°..	45°..	50°..	55°..	59°..	65°
Thrust in pounds...	215 ..	225 ..	240 ..	260 ..	290 ..	325

These tests show that the thrust would be decreased by having more of a point on the drill. With an angle of 37 degrees, however, the drill would not stand up well on the work. At 45 degrees the drill stood up to the work as well as at 59 degrees and with much less thrust. The moment remains practically the same no matter what angle is used, so that the driving power does not change with the angle of the drill.

In order to obtain the best results from the use of high-speed twist drills it is necessary to observe carefully the following points:

1. Do not immediately run the drill at a very high rate of speed, but feed it slowly into the work at a good practical speed, allowing the drill to make one or two holes before driving it at its full capacity. This will prevent the sharp cutting edges of the drill from chipping out and also the point from breaking off. After the drill has become thoroughly warmed up to the work, the speed may be increased considerably without any danger of breaking the tool.

2. The drill should be run dry on cast iron and usually no lubricant will be required on iron and steel. If a lubricant is used at all it should be an ordinary soap and water compound or some of the compounds on the market for this purpose. Do not use plain water as a lubricant.

3. In grinding the drill do not press the point too forcibly against the stone as it may cause a number of surface cracks which in due time will cause the tool to break. On account of the very fine quality of the steel, much care should be exercised in grinding to insure maximum results from the drill.

Do not heat the drill to a high temperature in grinding, as it will destroy the cutting quality of the steel.

4. The socket into which the drill fits should be in good condition and accurate in size so that the drill will fit into it perfectly; otherwise the tang of the drill may twist off or the entire drill split to pieces through no fault of the steel.

5. On account of the high speed and feed at which these drills are operated it is necessary that the work be securely fastened, any slight movement of the work may destroy the drill. The work should never be held by hand.

Grinding Tools.— Lathe, planer, boring mill, and all similar tools should be carefully ground on machines built specially for the purpose, and one man or one set of men should be in charge of this work. When a machine man wants his tool ground he should give it to the man in charge of grinding and get another the same size and of exact shape, a stock of tools being always kept ground and ready for use.

This method guarantees uniformity in the shape of the tool and will result in a maximum output of the machine in which it is used. If the shop is large enough to warrant it, boys should be employed to deliver tools to and from the grinding room.

Methods of Paying for Labor.— Straight shop time or the hourly rate is still the most common method used in locomotive repair shops to pay for the services of the workmen, and this method is so well understood by all shop managers that explanation is unnecessary.

The contract system is used to some extent in paying for certain classes of repairs among which may be mentioned forging iron by the ton from the scrap for locomotive frames, rocker arms, piston rods, driving axles, etc. This consists briefly in agreeing with the leader of a gang of men to pay a certain fixed price per ton for taking the scrap iron or steel and forging it into such shapes as may be most readily worked into frames, axles, or similar parts. The leader of the gang employs such help as he thinks advisable to use on the work and pays a certain price, previously agreed upon, for the services rendered. In large shops this method may also be employed in turning driving wheels, overhauling pistons and rods, removing, overhauling, and replacing steam and dry pipes, etc.

Another method of rewarding labor is what is known as the differential rate system of piece-work. This consists in offering two different rates for the same job. If the work is finished in the shortest possible time and in perfect condition, a high price per piece is paid. If the workman is longer in performing the operation than the time which the job should take, or if there are imperfections in the work, he is paid a low price for his labor. The chief merits claimed by this system are reduced cost of output and increase in wages.

Accurate knowledge in rate-fixing which prevents any desire on the part of the workmen to "soldier" or hold back on the work in an endeavor to deceive the management as to the exact time required to perform any fixed operation. More uniform and just treatment of the employees resulting in a corresponding increase in the quality and amount of work. The selection of the best men for each class of work and the sifting out of those who are incurably lazy or inferior. The promotion of a most friendly feeling between employee and employer. This system readily adopts itself to the manufacturing concern, but on account of the great variety and complex nature of locomotive repairs it is little used, if any, for railroad repair shops.

Straight Piece-Work.— Beyond straight shop time, the straight piece-work system most readily adapts itself to the railroad shop, and is fast becoming popular. It consists briefly in ascertaining the time necessary to perform each elementary operation and fixing a certain definite price to cover the same.

The duty of carefully timing each operation and fixing a price which will allow the workman to earn a reasonable amount over his daily rate provided work is of the proper quality and completed in the required time, is usually put into the hands of a person termed the speed boss, assistant to the general foreman, shop specialist, etc.

The following card will be found very convenient for use by the shop specialist in timing all machine operations. This card is equally applicable to operations in other departments, in which case, of course, the speeds and feeds are omitted.

A. B. C. RAILROAD COMPANY

Shop ____________________ Date ____________________

Description of Operation and Material ____________________

Machine ____________ Time Started ____________ Time Finished ____________

Speed		Feed Per Rev.		Time—Minutes		Time—Minutes		Time to Change and Grind Tools	Total Time Minutes
Rough Cut	Finish Cut	Rough Cut	Finish Cut	Rough Cut	Finish Cut	To Set	To Remove		

Name of Workman ____________________ Day Rate ____________

Remarks: ____________________

____________________ Assistant to Gen'l Foreman.

As fast as information for different operations is collected on these cards they are turned in to the office of the shop superintendents and the following permanent record card is made out in duplicate:

Schedule No. ________ A. B. C. RAILROAD COMPANY

RECORD OF OPERATIONS FOR ESTABLISHING PIECE WORK PRICES.

SHOP	DATE	CAR NUMBER	PATTERN NO. OR SHAPE NUMBER	CLASS ENGINE OR CAR

MACHINE	SHOP NO.	TOOL STEEL	MATERIAL	

DESCRIPTION OF OPERATION.

____

____

TIME SETTING	TIME MACHINING	TIME REMOVING	TOTAL TIME	ROUGHING CUTS			
				SPEED	FEED	DEPTH	NO.

FINISH CUT		NO. OF PIECES	OPERATIVE	RATE	COST PER PIECE	PRICE RECOMMENDED
SPEED	FEED					

____________________ Piece Work Inspector or Foreman. ____________________ General Foreman.

REMARKS: ____________________

APPROVED:

____________ Master Mechanic. ____________ Shop Specialist. ____________ Mech. Supt.

After these cards have been approved by the mechanical officials in the order in which the titles appear, the original is filed in the office of the superintendent of motive power and the duplicate returned to the master mechanic or shop superintendent as authority to use the price.

When piece-work prices have been fixed for all operations in any department, they are made up in detail according to the following illustration which is reproduced from a page of a piecework schedule in effect on one of the leading railroads.

A. B. C. RAILROAD COMPANY
MECHANICAL DEPARTMENT.

Pattern or shape number.	Schedule number.	Name of part and description of operation.	Price.
		ROCKER BOX	
		Halves planed to fit together as follows:—	
	B 304	Class G–1 to 4, each box,..	
	B 305	Class H–1 to 4, each box,..	
		Plane to fit frame, as follows:—	
	B 306	Class G–1 to 4, each box,..	
	B 307	Class H–1 to 4, each box,..	
	B 308	Old, re-planed for closing, each box,........................	
	B 309		
	B 310		
	B 311		
	B 312		
		SHOES AND WEDGES	
		Plane complete, except on back, for thickness, as follows:—	
	B 313	Class G–8–9, H–7, E–1, D–6–7–11, each..........	
	B 314	All others, each,..........	
	B 315	Plane for thickness, all classes, each	
	B 316		
	B 317		
	B 318		
	B 319		
		STEAM CHEST AND COVERS	
	B 320	New, plane complete, D–1–2, each,........................	
	B 321	Old, re-plane, one side only, D–1-2, each,................	
	B 322	Old, re-plane, both sides, D–1–2, each.................	

These sheets are bound in book form and put into the hands of the gang foreman and piecework inspectors for permanent use in the shop. A letter is placed before the number of each operation to distinguish one department from another in timekeeping and accounting.

W. S. COZAD,
Shop Specialist, Erie Railroad.

Railway Shop Timekeeping. The system of timekeeping herein described, if intelligently applied, will meet all requirements in every department of a railway shop, whether on a daywork or piece-work basis. It may be handled entirely with cards, with the single exception of the time book. The cards can be made from a cheap grade of manilla cardboard and will be very convenient to handle both in the shop and office.

Checking Employees to and from Work.—Assume, as an illustration, that the shop employs 1,000 men. These men would likely be distributed among the different departments about as follows:

Erecting shop	150 men
Machine and fitting department..................	250 men
Boiler shop	200 men
Blacksmith shop..	150 men
Tin, pipe and copper department, paint shop, carpenter shop, laborers, etc....................	250 men

To maintain a proper check on 1,000 employees, it would be necessary to establish check rooms or booths at perhaps four different points in the shop so that they will be easily accessible to the men and to allow proper handling of the cards within the limited time allotted for this purpose.

In this booth may be located a case containing about 250 separate departments as shown:

1			
2			1–100
3			
4			
etc.			101–200

At each one of the points an opening may be made in the wall of the room similar to the window in a ticket office, and through this window the card shown in the illustration below should be delivered to and received from the men:

No.____________ A. B. C. RAILROAD CO.

Daily Time Record of______________________Shop______________Date__________190___

CHARGE	PIECE WORK		DAY WORK		HOURS	DESCRIPTION OF DAY WORK
	COMMENCED	FINISHED	COMMENCED	FINISHED		

Correct:____Foreman.

One of these departments should be assigned to each employee and be so designated either by his name or number. In small shops where timekeeping is handled in the office of the general foreman, the departments on the right, numbered 1–100, 101–200, etc., can be used as a permanent file for piece-work cards.

At the end of each month, a sufficient number of cards (one for each day in the following month) should be stamped with the department, the employee's name, and placed in the proper "pigeon hole" in the case. This can be done with one blow of a rubber stamp with movable type, by having the block so constructed as to fit the blank spaces on the card. A bright, active boy can accomplish this work for 250 men in about two days.

The shop, office, or booth in which these cards are kept should be opened 15 minutes before the whistle blows and the person entrusted with this work must be on duty ready to give out the cards as the employees call their name or number — numbers are preferable because when a man leaves the service the person employed to fill his place can take the original number without any change whatever in the filing case. As each man passes the window arranged for this purpose and calls out his number, the card should be taken from his respective department in the case, the date and time of entering service stamped on it with a rubber stamp and passed out to him. At 12 noon the window is opened and the cards received from the men as they pass on their way out. During the noon hour the cards should be distributed in the case, and at 12.45 P. M. the window is opened again and each employee receives his card after the time at which he commences duty has again been stamped on it. This is his certificate to show that he was in the shop and ready for service at the time prescribed by the company. At 6 P. M. these cards should be collected at the window from which they were received by the workmen, approved by the foreman, and turned in to the office of the general timekeeper, where they should be properly entered in the daily time book.

At precisely 7 A. M. and 1 P. M. the windows should close, and any employee coming in after that hour may be required to apply at the office for the card, which should have marked on it in red ink the time at which he enters service. Any workman entering service without his "Daily Time Certificate" properly marked should be liable to lose the time for that half day, subject only to the discretion of the shop superintendent.

The card used to check employees in and out of shop will answer in every department of railway repairs, both cars and locomotives, in making daily record of all shop or day-work time.

The only difficulty to be guarded against in handling this work is in securing the proper charge. If the cards are allowed to pass unchecked by the gang foreman of the department, the men are liable to become indifferent and careless in fixing the exact number of hours against each engine or account where their work is of a miscellaneous nature. These cards should be carefully checked each day by the foreman in charge to obtain satisfactory results. In shops where a part of the time is on a piece-work basis this should be recorded on the following card:

Card No.__________

A. B. C. Railroad Company

Piece Work Card

__________ Shop __________ 190____

Charge To	Schedule	No. Pieces	Price	Cost

Distribution

Earnings Pc-Rated

Day Rate

Total Hours

Date and Hours Labor Performed.

Date	Hours

Names of Workmen

Number

__________ Piece Work Checker

__________ Foreman

To handle this card successfully it is necessary to have piece-work inspectors to inspect the work and use this card in making a proper record of the time. The piece-work inspector or time inspector as they are called in some shops should personally see each man who is paid by the piece, at least once a day, inspect the quality and amount of work which he has done, and by use of the schedule referred to on a previous page, make a careful record of the number of pieces and the price per piece, extending it as indicated on the card.

This inspection should be repeated day after day until the piece-work record card is full of items when either the total amount can be carried to the top of another card and the operation continued or the card may be totaled.

properly signed, and turned in to the general timekeeper for entry in the time book.

This book should be printed in a size which will meet the requirements of the plant.

The time recorded on the piece-work card should be entered in the book according to the card number and to the man who performed the work. Where two or more men work together on an operation covered by a piece-work price, the number of hours worked and the amount earned by each should be entered in each case against the card number.

In recording the shop time where the cards are turned in each day, the distribution of the different charges should be made when the time is entered in the book and the cards filed in a case arranged in alphabetical order so that they will be readily accessible in case of error or dispute.

A combination piece-work and day-work time book may be printed according to the following illustration:

A. B. C. Railroad Company

Piece-Work

Name____________________ Name____________________

Occupation____________________ Occupation____________________

Date	Card number	Hours	Rate	Amount	Date	Card number	Hours	Rate	Amount

SHOP TIME Day Rate____________Per Hour

Charge	Date																						Day rate	Amount

The piece-work inspector should know his men and the position in which he will find them in going from one machine to another and from one gang to another in the shop and he should be provided with the necessary means in the foreman's office to arrange the cards accordingly.

When these cards are received in the office of the timekeeper they should be numbered consecutively from one up for each department, commencing with the first day and continuing through to the end of the month.

The above illustration shows a leaf of the time book for recording day-work and piece-work time.

Best results will be obtained by entering all shop time once each day, and in shops where charges to different accounts are numerous this book can be printed so as to use one page for piece-work and the opposite page for shop time; or, the book may be made large enough to provide ample room for both entries on same page.

In making out the monthly distribution of the various charges for work done in the different departments the form below will be found very convenient.

This sheet can be printed in a size to meet the requirements of the shop and a space left at the top of each column for the engine number or other charge. By the use of these sheets

Distribution Sheet

________________Shop for________________19________

Engines						Cars						Expenses						Shop Orders					

the charges on the piece-work cards can be transferred as often as they are sent in from the shop, thereby distributing more evenly the office work through the month. Wm. S. Cozad,

Shop Specialist, Erie Railroad.

Railway Signals. The subject of railroad signaling (with fixed signals) falls under three heads: the block system, concentration of switch and signal levers, and interlocking. The second and third may be considered as one. Block signals are used to maintain an interval of *space* between trains following one another. The regulation of trains by the maintenance of an interval of *time*, at stations, is imperfect because, if, in the case of a curved line or when the engineman's view is obscured by fog or falling snow, the foremost of two trains is unexpectedly stopped and delayed between stations, a collision may ensue in consequence of the negligence of a flagman or an engineman, or failure of lights or torpedoes. The block system at first was maintained by the employment of signalmen at each station, who, by telegraphing one to another, regulated the movement of the trains. The high cost of this system, due to the necessity of employing an attendant night and day at every station, led to the invention of automatic signals, which render the signalmen unnecessary. The large item of wages being saved, the block sections can be made as short as may be desired, thus increasing the capacity of the railroad by enabling trains to follow one another more closely.

The levers working a group of switches are concentrated, primarily, to save the time and labor of the switch tender, who otherwise must be continually running from one switch to another; but the principle is applicable, of course, to any number of switches within workable distance, say 500 to 800 feet; and at a city passenger terminus one man is able to attend switches which otherwise might require a half dozen attendants. The levers working the signals are of course likewise concentrated, and all are supported in a frame together. Interlocking is necessary where levers are concentrated, because moving a number of levers in wrong sequence may lead to a collision of trains. At a crossing of one railroad with another, for example, the attendant might inadvertently give clear signals on both of the lines at the same time. By locking the levers, one against another, so that he cannot do this, such an error is made impossible. At a drawbridge the signals controlling the movements of trains are interlocked with the apparatus by which the draw is locked in position. At drawbridges, and also at most crossings, a diverging track or a derailing switch is provided, so as to divert a train in case its engineman disobeys the stop signal.

The Telegraph Block System.— In this system, communications are made, in England, with apparatus like the needle telegraph, and in America with the Morse telegraph. A short code of signals by electric bells answers all ordinary purposes, and this is used in many cases. The telephone is also used to a limited extent, and is used as a convenience where the bell-code is the main reliance. The diagram (Fig. 1) represents the block signals at a single station, which we will call station *B*. The east-bound track only is shown. The principal signal, called the home signal, is shown at *b*. When a train is ready to proceed from *A* to *B* the attendant at *B*, receiving notice from *A*, replies, saying whether or not the line from *A* is clear as far as signal *b;* in other words, whether or not the last preceding train has passed wholly beyond *b*. If the line is clear, *A* then permits the train to proceed. If the line from *b* to *s* (the starting signal) is clear, *B* may put signal *b* in the all-clear position and permit the train to enter the section between *b* and *s*. If the last preceding train has reached station *C* and has been reported clear of the block section *B*-*C* signal *s* may also be cleared, indicating that the road is clear to *C*. When both *b* and *s* are cleared, the distant signal, *d*, may also be cleared, but not otherwise. The distant signal, when its arm is in a horizontal position, indicates that the train must stop at *b*, but when the arm is inclined downward it indicates that *b* and *s* are both clear. In case of fog or snow-storm, or if the engineman's view is obscure in consequence of a curve in the line, this distant signal obviates the slackening of speed which otherwise might be necessary to enable the engineman to make sure of a clear signal at the home signal *b* before passing it. The signals referred to are semaphores, one of which, with a wooden post, is shown in Fig. 2. On American signals the arm or blade always extends to the right; in England to the left. The upper arm gives the indications, as just described, for the main line. The lower arm is to give indications for diverging tracks (supposing there were such a track at *T*, Fig. 1). The casting at the left hand end of the blade is fitted with a red glass spectacle for giving the «stop» indication at night. When the arm is inclined downward, to indicate all-clear, the spectacle is lifted, disclosing the white (uncolored) light, the all-clear signal. Where green is used for the all-clear indication at night, a double spectacle, with both red and green glasses, is provided. The counterweight *c*, one for each arm, serves to return the arm to the horizontal or stop position in case of breakage of the wires. On some railroads the semaphore arm is made to take any one of three positions: horizontal for stop, vertical for all-clear and half-way between, meaning «caution.» On certain other roads the arm is inclined 45° upward from the horizontal to indicate caution. Where signals are required for two parallel tracks they may be set on a «bracket-post» as shown at *A* (Fig. 2). At *B* (Fig. 2) are shown home signals for movements in the same direction on two parallel lines, and distant signals for the same lines, the distant signals regulating the approach to home signals farther on. For low-speed movements, as from a siding to a main track, a dwarf signal is used (*C*, Fig. 2). Where signals are required for more than two tracks side by side they are usually set on a bridge spanning the tracks above the tops of the cars. Signals are further explained below, under *Interlocking.*

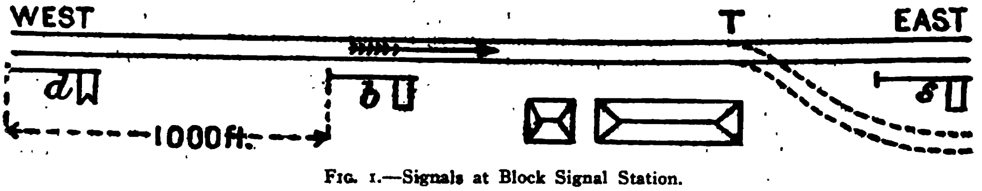


Fig. 1.—Signals at Block Signal Station.

To provide against errors of signalmen, W. R. Sykes and others have devised electric controlling apparatus, so that to admit a train to a block section it is necessary to have the concurrent consent of the signalman at both the entering and the outgoing ends. This arrangement is called «controlled manual» or «lock-

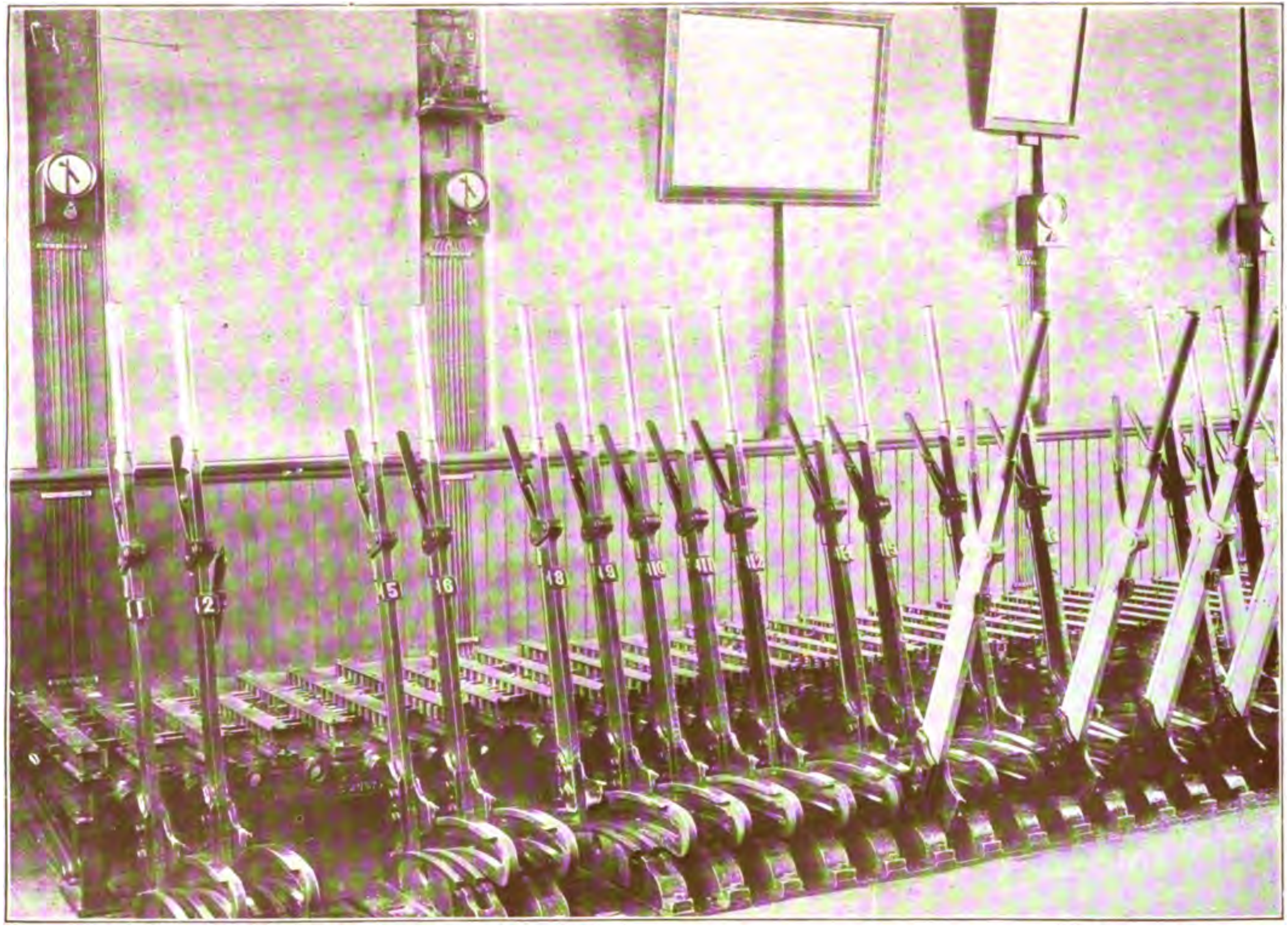


FIG. 9. INTERIOR OF SIGNAL CABIN.

Manuel Switch and Signal Levers   The Locking back of the levers, is arranged in a horizontal frame.   The arrangement in fig. 10 is for a vertical frame

and-block.» It is used on the London, Brighton & South Coast Railway and others in England and on the New York Central & Hudson River, the New York, New Haven & Hartford, and others in America.

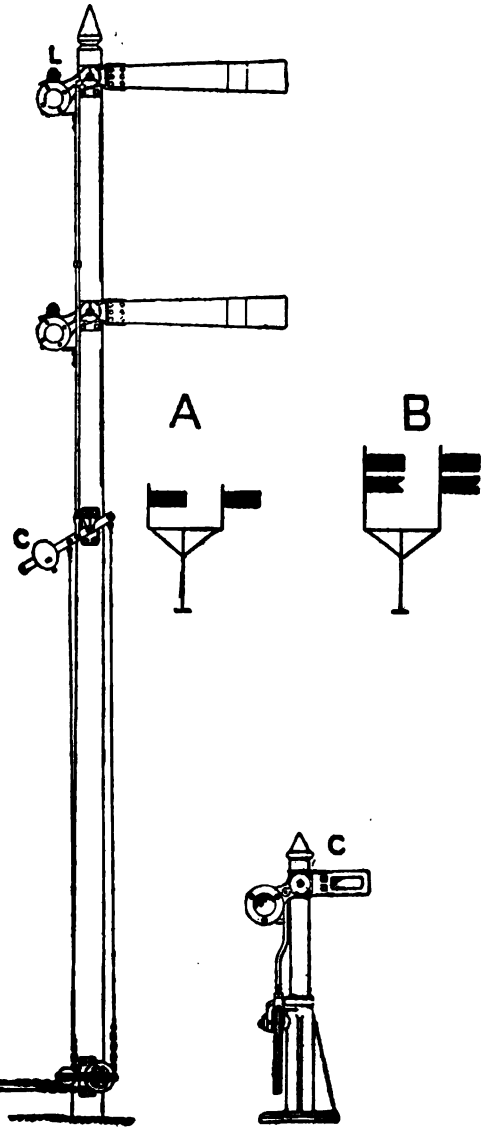


Fig. 2.—Semaphore Signal 24 ft. high; arms in position to indicate "stop." C, counterweight; L, lamp. A — Signals on bracket post for trains moving in the same direction on two parallel tracks. B — Home and distant signals for parallel tracks; home for the section immediately in advance, distant for the section beyond. C — Dwarf signal, tor slow movements.

Electric Train Staff.— For signaling on a single track railroad, where it is necessary to provide not only against collisions between trains running in the same direction but also between trains running toward each other, the apparatus of Tyer and of Webb & Thompson is used. In these a «staff» of wood or metal 20 inches long, or a round tablet about 3 inches in diameter, is delivered to the engineman as a symbol to give the train the right to the track from station to station. Possession of this emblem assures the engineman that no other train is in that section. A magazine filled with staffs or tablets is provided at each end of a block section, and after one of these is taken out (at either end) no other can be taken out, at either end, until the first has been replaced at one end or the other. This control is effected by a lock, governed by a polarized electro-magnet. The magnets at the two stations are electrically connected by a wire, and withdrawal of a staff at either station locks both magazines, while the return of the staff to either unlocks both. The staff system is modified by a «permissive» staff or a staff with tickets; then two or more trains may follow one another in the same direction, while still the entrance of a train from the opposite direction is forbidden. A semaphore signal, giving permission to a train to enter a block section is in some cases interlocked with the staff apparatus, so that the signal indicates «stop» to entering trains until the staff has been taken out of the magazine and used as a key to unlock the signal. These single-track devices are used in England and Australia much more than in America.

Automatic Block Signals.— These are controlled by electro-magnets actuated by an electric current flowing through the rails of that portion of the track which constitutes the section to be protected. From a battery at the out-going end of the section the current flows through the right-hand rail to the signal at the entering end; thence through the coils of a relay at that signal, and back through the left-hand rail to the battery. The track being free from all vehicles, the relay is energized by the current; and by means of magnet *s*, explained below, it holds the signal in the all-clear position. The presence of a train (or car) in the section de-energizes the relay by making a short path for the current, through the wheels and axis, from one rail to another, and this allows the signal to change by gravity from the all-clear to the «stop» position.

The connections for a simple automatic block signal circuit are shown in Fig. 3. The current flows from battery 12, at station C, through the rails on one side to station B, thence by a wire to the relay *r*, through its coils, and thence back to the battery by the rails of the other side of the track. At the ends of block sections (*a*) the rail-ends are insulated one from the other; and all the other rail joints are fitted with bond wires to insure a good electrical conductor throughout the section. At a switch, as at *v*, the track circuit is run through the rails of the side-track for a short distance so that if a car on the siding should be left standing so as to foul the main track, the current would be short circuited, throwing the signal to the stop position. As the insulation of the rails is poor, the battery for a track circuit must be of low intensity. The usual battery consists of two cells, gravity. In many cases the wire 13 by which the relay *r* controls the signal magnet *s* is extended, on poles, to the switch *v*, and to all switches in the section; and the setting of the switch for the side track is made to set the signal against approaching trains. In other cases the breaking of the track circuit at *v* is relied on for this. On a single-track railroad automatic signals must, of course, be arranged to give indications in both directions, and the relay of a given section not only controls the signal to which it is attached but also, by means of a wire run on the telegraph poles to the other end of the section, it controls a similar signal (on the other side of the track) at the far end, which gives indications to trains moving in the opposite direction. To provide against the possibility of a collision, in case opposing trains should enter a section from opposite ends at the same instant, the track circuit of each section is made to control not only its own signals but one other signal, farther off, in one direction, thus ensuring to at least one of the two trains the warning of two successive signals.

The actual movement of the signal is produced not by the track relay with its weak current, but by a weight and clockwork, controlled by magnet *s;* or, electro-magnet *s,* worked by a local battery, may itself be made powerful enough; or an electric motor may be used; or compressed air or gas. The clockwork, and the electro-magnet, were the usual sources of power until the demand arose for a larger signal. The clockwork signal, Fig. 4, is a disk 20 inches in diameter, turning on a vertical spindle. The signal worked by an electro-magnet is a very light disk enclosed, to protect it from wind, rain and snow, in a case with a glass-covered opening. It turns on a horizontal axis (see Fig. 5).

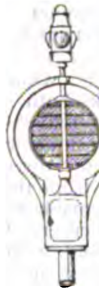


FIG. 4.—Union Automatic Clock-Work Block Signal. Disk, 20 in. in diameter, turning on vertical spindle. The cut shows the signal in the "stop" position; to indicate all-clear it is turned with its edge toward the approaching train. The lamp, turning with the disk, indicates at night white or green for all-clear, red for stop. The disk is made of loose slats to reduce resistance to the wind. The clock-work weight is suspended within the hollow iron post.

For a large signal (semaphore) which cannot be protected from wind, rain and snow, compressed air was introduced as a motive power (see Fig. 6). For a series of signals an air compressor is provided at a central point which conveys pressure, through an iron pipe, either buried or above ground, to all of the signals along a section of 10 or 20 miles. Later, electric motors were adapted to this use, doing away with the expense and annoyance of the pipe, and substituting electric power for the compressor. The motor is worked by a primary battery and both motor and battery are usually contained in a box at the foot of the signal post (Fig. 7). A modification of this is the provision of storage batteries, charged through a power wire, conveying current from a dynamo situated at a central point; or, storage batteries may be taken out and carried to a charging station when exhausted. The electric motor is cheaper than compressed air, but further efforts to reduce cost and to supply each signal with a larger independent reservoir of power led C. J. Coleman to devise the liquid gas signal, in which the motive power is liquid carbonic acid gas, contained in a cylinder under high pressure. The cylinder is put in a pit at the foot of the post. A second cylinder (in the pit) is connected when the first is exhausted, and fresh cylinders are brought as often as needed. A reducing valve regulates the working pressure.

In automatic signaling the distant signals are usually fixed on the same posts with the home signals; for example, the distant signal for signal 11′ section C-D is fixed on the post with signal 11, below home signal 11. Signal 11′ may control the distant signal at 11 by a current through a wire run on poles, or by a pole changer which when signal 11′ goes to the stop position, changes the polarity of the track circuit B-C. In place of relay *r* a polarized relay is used, the relay in its ordinary function controlling the home signal and on the polarized side controlling the distant signal.

On the Boston Elevated railroad, running very frequent trains, and with short block sections and trains of uniform length, an automatic stop is used. This is a device, fixed on the sleepers, working in unison with the block signal, which, when the signal is set to indicate stop, is moved into a position near the rail where it will strike a trip on the leading car and cause the air-brakes to be applied; so that any train which passes a stop signal is stopped in spite of anything that the motorman may do or neglect to do.

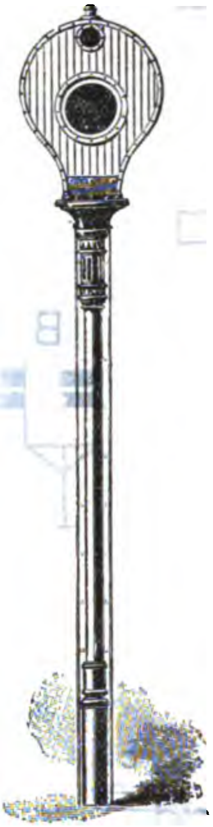


FIG. 5.—Hall Enclosed Disk Signal, 18 ft. high. The disk, which shows in the large glass-covered opening, is made of colored silk or celluloid, it indicates "stop." To indicate all-clear the disk is withdrawn from its position in front of the opening. The upper opening is for the night indications; a colored glass is in front of the lamp when the disk indicates stop and is withdrawn when the signal changes to "all-clear."

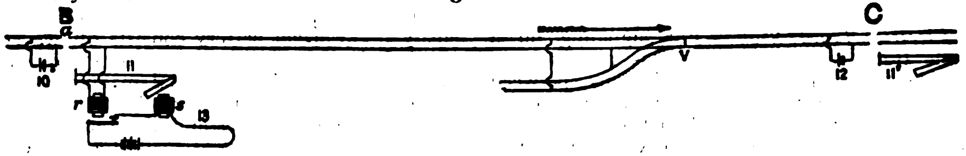


FIG. 3.—Automatic Block Signal Circuit. A section (B–C) is usually from 3,000 ft. to 5,000 ft. long; 10, 12 track batteries; 11, 11′ automatic semaphore block signals, in position to indicate all clear; *r,* track relay; *s,* signal magnet; *v,* switch.

To avoid the expense and complication of a distant and a home signal at every post, the three-position automatic signal was devised. In this, the semaphore arm when horizontal indicates stop, as with other signals; and when vertical it indicates proceed at full speed; but when it is at an angle of 45°, it indicates *stop at the next signal,* which makes it virtually a combined home and distant signal. As a home signal it means (in this last position) «proceed,» but as a distant signal it means «stop» (at a point farther on). On electric railroads the rails of the track are used for the return of the powerful electric current used for the propulsion of the cars, so that an arrangement has been devised to control automatic block signals by the use of only one of the rails of the track. By the use of a polarized relay the difference in potential between the left-hand rail and the right-hand is made to control the signal magnet. This arrangement has not yet (1904) come into general use. The electric-light signaling apparatus used on electric railroads do not come within the scope of this article, as they lack important features which signal engineers deem essential to correct signal practice.

Permissive Block Signaling, as mentioned in connection with the electric train-staff, is practised under all of the different systems. With the telegraph block system, stations are usually 2, 3 or 4 miles apart, and when freight trains are unusually numerous, it often becomes necessary to run them nearer together than this, and so a permissive signal is given. The engineman running under such a signal must slacken speed, if necessary, at curves, or in case of fog, so as to avoid the possibility of striking any train ahead. With the controlled manual system the controlling apparatus is useless, if permissive signals are given. With automatic signals it is necessary to allow all trains to proceed permissively after having stopped at a block signal, because the signal may be indicating «stop» on account of some derangement of the apparatus, and there is no signalman at hand to give positive information as to whether or not the last preceding train has cleared the block section.

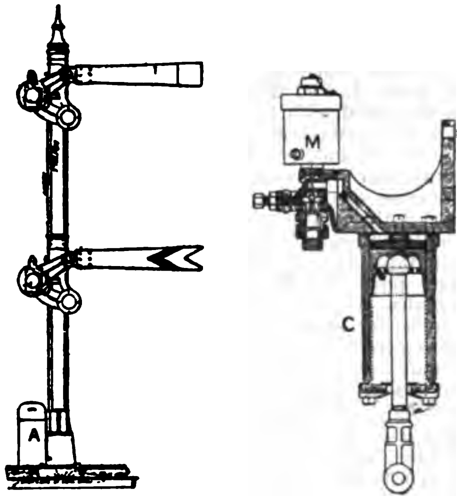


Fig. 6.—Electro-Pneumatic Semaphore Signal (short post to stand on overhead bridge). The signal arms are moved by vertical rods within the tubular iron post. The operating cylinder C is contained in the box A at the foot of the post. Admission of air to the cylinder is controlled by electro-magnet M.

Interlocking.— Fig. 8 shows two switches and four signals. To permit the passage of a train, say train No. 10, along the main line from *a* to *b*, the switch 3 in the main line track must be «straight»; switch 3, in the siding, must also be straight, so that any attempt to move from *c* to *b* (which would foul the path of train No. 10) will be thwarted; and signal 2 must be put in the all-clear or «proceed» position, giving notice to the engineman of No. 10 that the

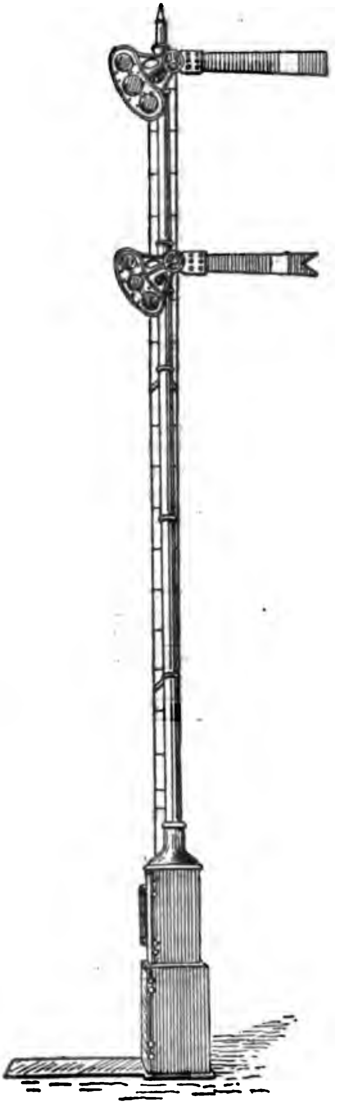


Fig. 7.—Automatic Semaphore Block Signal. The upper part of the box at the foot of the post contains the electric motor and controlling mechanism, the signal arms being moved by rods within the tubular post. The lower part of the box contains the battery for the motor, or, in the case of a gas signal, may contain the gas holders. Of the three glasses in each spectacle, the two upper ones indicate stop, taking the place of a single elongated glass; thus stop is indicated (at night) until the arm moves down fully to the all-clear position.

switch ahead of him is in the right position. The movement of the levers in this sequence is compelled by the interlocking. Lever No. 2 cannot be moved to clear the signal until lever No. 3 has been put in the right position; lever No. 3, working both switches simultaneously, cannot be moved until lever No. 4, working signal 4, is «home,» in which position it must be when that signal is in the stop position, forbidding a train to proceed from *c* eastward. Near each switch there is a detector bar *g*, connected with the lever moving that switch, which prevents the signalman from carelessly changing the position of the switch while a car or engine stands over the detector bar. The bar lies close to the rail, on the outside thereof, and it must be lifted whenever the switch lever is moved; but the presence of a car-wheel will keep it from rising, and thus will prevent the movement of the switch lever. The signal at 1, with a fish-tail arm, is a distant signal, the function of which has been explained.

Switches are usually connected with the cabin or tower by iron rods (gas pipes) supported a few inches above the ground at short intervals on rollers; signals are connected either by rods or by wires. Bell cranks are introduced where it is necessary to abruptly change the direction of a rod. A long rod or wire must be provided with a compensator to obviate difficulty from expansion and contraction due to changes in temperature. For the rod, a simple arrangement of levers, called a «lazy jack,» is used. With a wire, the connection at the cabin must be readjusted as often as a change in temperature occurs. A number of more or less satisfactory automatic devices are in use for this purpose.

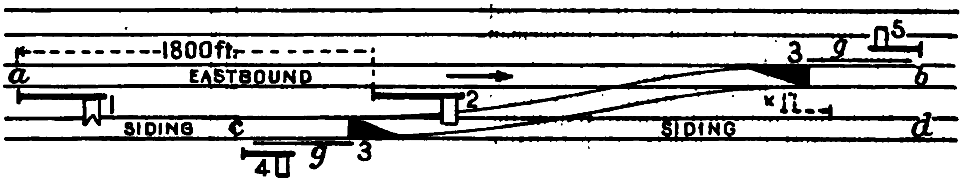


Fig. 8.—Interlocked Switches and Signals.

Where a number of levers are concentrated in a cabin, they are fixed on a common horizontal axis. One such lever is shown in Fig. 10, the axis being at X. The interlocking is effected, not by the lever, but by its latch V, so that the locking is «preliminary.» For example, if the signalman starts to pull lever 3, to move switch 3, the preliminary act of unlatching it locks lever 4 before switch 3 begins to move. Lifting latch V moves a vertical rod or tappet N; this by means of a mitered dog, moves a horizontal bar in one of the grooves, G, a distance of about one inch, and thereby locks lever 4. If lever 4 were in the wrong position, it would obstruct the movement of the horizontal bar, and thus warn the signalman that he was attempting to pull the levers in the wrong order. The horizontal bars are made of any length necessary to reach the farthest lever in the frame, perhaps 50 feet, or more.

Power Switch and Signal Apparatus.— For the very numerous movements in a large yard, like a city passenger terminal, the working of switches and signals by manual power is laborious and comparatively slow, and pneumatic and electric machines have been devised to do the work. Where a manual machine requires, say, five men to work the levers, it is possible, by the introduction of power (which also saves steps by concentrating the levers in a smaller space), for one or two men to do the work. In the Westinghouse electro-pneumatic machine, compressed air, at 70 pounds per square inch, from a reservoir at the signal cabin, is conveyed in pipes, laid underground, to cylinders, one at each switch and one at each signal, in which the pressure, by means of a piston, moves the switch or signal. (A signal cylinder is shown in Fig. 6.) The admission of air to a cylinder is controlled by an electro-magnet fixed at its side, and the circuit of this magnet is controlled by a miniature lever (circuit-closer) in the cabin, the wires, like the pipes, being run underground. These little levers are suitably interlocked, the same as the large levers in a manual machine. The movement of a lever to work a switch does not, however, actuate the interlocking which releases the lever to be moved next; for the lever movement does not insure that the switch has actually been moved, it only closes the circuit. The next lever is held locked, until, by an electric current, the circuit of which is closed by the switch rails themselves, after their movement is completed, the «indication» of such completion is sent back to the cabin, permitting the unlocking of the next lever.

Following the introduction of the electro-pneumatic machine, the experiments of F. L. Dodgson showed that the electric current could be dispensed with by using air impulses to control the admission of compressed air to the working cylinders. Air is not so quick as electricity, but it answers all practical purposes at moderate distances. In his machine, the pressure in the power pipes is controlled by a valve, opened and closed by a leather diaphragm, which diaphragm is moved by air conveyed in a separate pipe. In this, the «all-air» system, the pressure in the cylinders is usually only 15 pounds per square inch, and in the small pipes leading to the diaphragm valves, it is only 7 pounds per square inch. The signalman's work consists in opening and closing valves by means of sliding bars (called «levers»); and the interlocking is the same as in other machines.

The «all-electric» switch and signal apparatus was developed by J. D. Taylor. A switch is moved by a one-horsepower electric motor fixed to the sleepers and worked by an electric current conveyed by wires from a dynamo or storage battery in the cabin. For a signal, a motor of one sixth horsepower is fixed to the signal post. The storage battery is usually charged by a generator run by a gasoline engine; and the amount of electric power used is so small that a small engine need be run but a few hours daily.

The machine in the cabin consists of a

frame supporting horizontal sliding bars (called «levers»), each movement closing the circuit to a switch or a signal. The «levers» are interlocked, as in manual or pneumatic machines; and, as in other power machines, the interlocking is controlled by an «indication» sent to the machine from a switch after the switch has actually completed its movement. This «indication» current is generated by the momentum of the switch motor, which is converted into a generator for a fraction of a second after it has completed its work of moving the switch. The movement of a switch requires a current of only seven amperes. Dwarf signals are worked by solenoids.

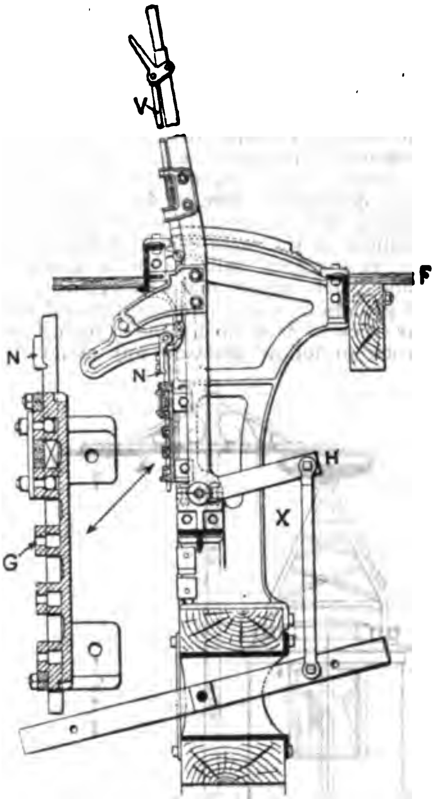


Fig. 10.—Signal Lever and Interlocking Tappet. F, floor of cabin; G, groove for interlocking bar; N, tappet; V, latch rod.

The railroads in the United States in 1904 aggregated over 200,000 miles. Of these lines, a length of about 4,400 miles was equipped with automatic block signals. Three fourths of this mileage is double-track railroad and about 300 miles is four-track. On about 22,500 miles of the railroads in the United States, trains run under the telegraph block system. In Great Britain and Ireland, all of the railroads carrying passengers are worked by the telegraph block system. On the continent of Europe, only the more important lines have the block system.

Automatic clock-work signals are used extensively in New England. The enclosed disk signals are used principally in New England and on the Lehigh Valley, the Philadelphia & Reading and the Chicago & Northwestern railroads. Electro-pneumatic block signals are used extensively on the Pennsylvania Railroad; also on about 30 miles of the Central of New Jersey, and, for shorter distances, on the Burlington and other roads. Electric motor signals are used extensively on the Illinois Central, the Delaware, Lackawanna & Western and the Chicago & Alton, and are being introduced on many other roads. The electro-gas signal is in use on the Delaware, Lackawanna & Western, the New York Central and other roads.

The manual interlocking machines in the United States aggregate about 45,000 levers. The electro-pneumatic interlocking is in use at numerous points on the Pennsylvania railroad, at the two large terminal stations in Boston and at Chicago, Saint Louis and other cities. The «all-air» interlocking is in use at the Grand Central Station, New York, and at large stations in Chicago and other cities. The «all-electric» interlocking is in use at large stations in Chicago and at a large number of smaller places, this system being peculiarly adapted to places remote from a power station.

B. B. Adams,
'The Railroad Gazette,' New York.

Railway, Single Rail Type. An important development in railways is that known as the single, central or monorail system. The first idea of a single-rail railway dates back to

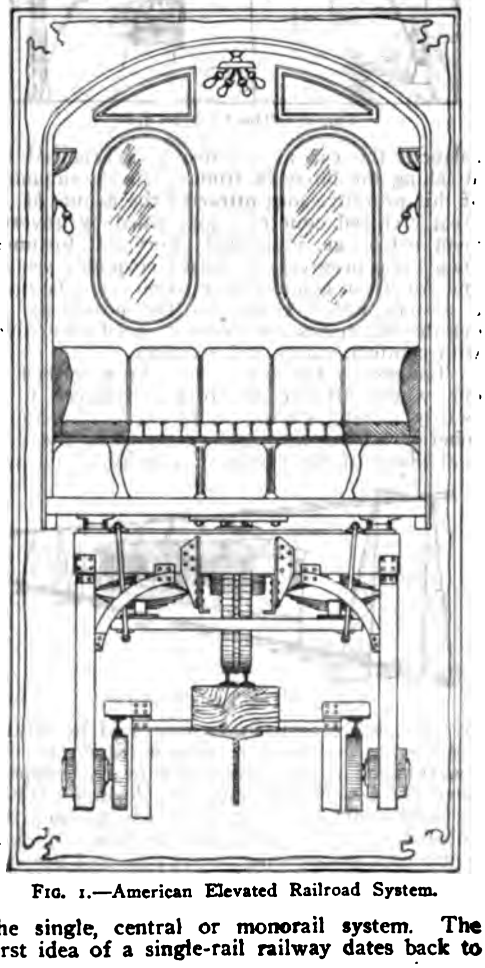


Fig. 1.—American Elevated Railroad System.

one hundred years ago, and many such are now being used in various parts of the world.

The first car run on a single rail, the invention of M. Charles Lartigue, has been in practical operation for many years in Djiboniti, a French African post. The car is kept vertical by its attachment to a laterally placed horse, which balances the car as a hansom is balanced by attaching the horse in front. The development of this primitive idea attracted the genius of all great civilized countries, and aided by government patronage, individual effort and fortunes, made great progress, but finally corporate wealth and American genius perfected on scientific lines a system which eliminates the possibility of derailment, makes the greatest speed attainable, with comfort, safety and economy.

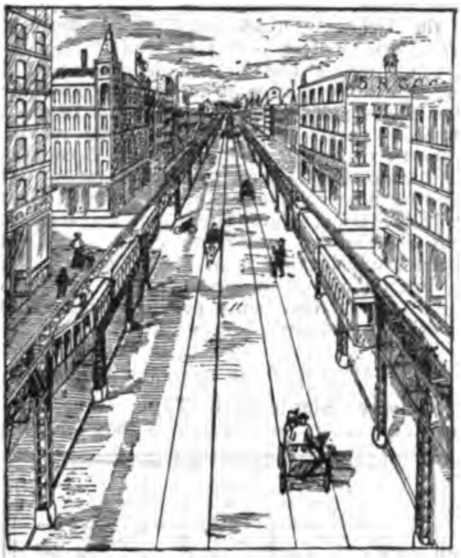


Fig. 2.—The Cook System.

Technically the system may be described as one where all the different resistances to a swiftly moving car or train, except the atmospheric resistance, are concentrated in the vertical plane of the centre of gravity of the car or train, being partially concentrated by centrifugal force, and those resistances which are not concentrated at the centre are nearly compensated for by friction removing devices. When the said body is at rest, or slowly moving, the unbalanced forces, only, are mechanically concentrated with a minimum friction, and the stability is positively and absolutely preserved without jarring movement. The downward vertical force consists of the weight of cars, trucks and load. This weight is delivered to, and directly sustained by, two centrally disposed bearing rails laid with precision as to alignment and surface, and closely gauged to each other, so as to constitute practically a single support, while the vertical integrity or stability of the weight thus delivered to a central point is conserved when necessary by upward forces acting through the medium of dependent tension members, fitted with frictionless wheels bearing against inverted girders or rails; when moving at speed, stability is almost entirely preserved naturally and automatically, and only slight strain is on the dependent tension members. The magnitude of the downward forces is a matter simply of weight of cars; the upward forces are a matter of mechanical moments or leverages; the upward forces may amount to 10 per cent of the downward forces for usual cases. The downward force is delivered through the medium of the main central wheel, bearing on the two central rails as on a single rail. The side clutch wheels, that bear against the inverted girders or rails, guide, clutch and secure the car truck to its normal plane or path, forcing the truck to follow precisely any assigned inclination; for example, around curves. The central bearing rails and the inverted side clutch rails being laid with precision as to line, grade and inclination, the lateral and top-heavy swaying and recurrent oscillation now observable in locomotives in motion can never obtain; nor can the truck derail, as it is clutched to the track.

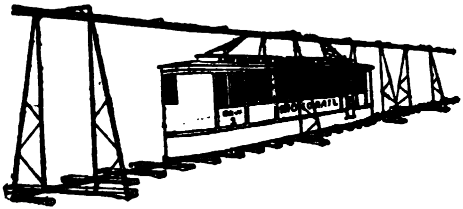


Fig. 3.—The Tunis Monorail.

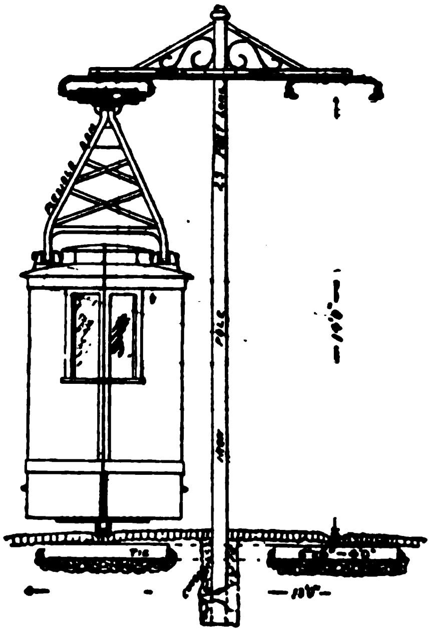


Fig. 4.—For surface street construction, showing overhead truck at the maximum height of 14 feet.

Upon the curves, the inverted rails are pitched (the one elevated and the other depressed) to an amount co-ordinate to the radius of the curve and speed. The lateral or tipping tendency of the trucks being always controlled, the car bodies resting upon the truck-bolster will have a base of support free of much pulsatory irregularity of motion now inseparable from moving cars.

The propulsion of cars is effected by electric motors, two or four motors to each truck, the number of motors being dependent upon the starting pull, acceleration and speed required.

The cars are mounted on two trucks; each runs on two bearing wheels, which follow the same central line; this mechanical sequence is economical of power, or draw-bar pull. The inverted rails do additional service as conductors of electrical currents by which the system is operated. This inversion of the charged rails avoids all the difficulties attending the operation of a third rail system.

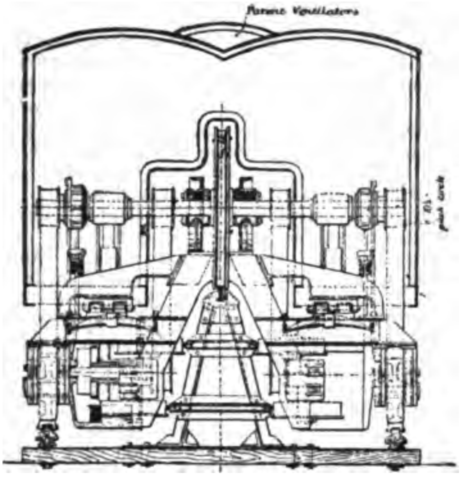


Fig. 5.—Behr System.

This system solves the high speed problem, and makes possible the elevation of passenger, mail and express service from overcrowded standard gauge steam roads, converting non-paying passenger traffic into the most profitable department of railroad business.

Concerning the monorail system of the American Elevated Railroad Company, described above, Mr. George H. Thomson, M. A. Soc. C. E., M. Inst. C. E., says: «After careful study, guided by years of experience in the location, construction, operation, and maintenance of railroads, I do not hesitate to approve and recommend, as overcoming many of the deficiencies of existing railroads and as marking a new departure toward the railroads of the future, with accompanying safety, comfort and economy.»

While the monorail system is acknowledged to have reached its highest development in the United States and under the management of the American Elevated Railroad Company, yet no little credit is due to European endeavor and many American inventors. Among the American inventors whose efforts have attracted public attention should be mentioned Col. George S. Broot, of Washington, D. C.; E. Moody Boynton, of Massachusetts; Lina Beecher, of Batavia, N. Y.; William B. Mack, of Boston, Mass.; Howard Hansel Tunis, of Baltimore, Md.; Dr. Adolph Brodbeck, of the University of Nashville, Tenn.; L. F. Cook, and Dr. L. C. d'Homergue, of Brooklyn, N. Y.

William B. Mack's design, shown here, appears to have been awarded more consideration among engineers than any of the many similar plans patented. As far back as 1872 a charter was granted in the State of New York for the building of a hanging railroad which had the general mechanical principles of the hanging roads more recently exploited in Germany, France, and Russia, but the Cook system, shown here, appeared to be the only serious effort made to date at hanging cars on the side of the structure in place of underneath.

E. Moody Boynton patented plans for a monorailway which were approved by such experienced railroad men as Austin Corbin. Several short test roads were built and operated. The Tunis plan here illustrated, is a modification of Boynton's. As will be seen, the single rail is laid on the ground like the rails of steam roads and trolley lines. Over the single rail at fixed intervals are trusses, or bents, joined by cross pieces at the top and supporting the guides which prevent the car from toppling over. The car itself also embodies some unique and interesting features. It is narrower than the standard trolley or railroad car and rests on a single pair of wheels, or, in the full-size coach, on two trucks of two wheels each, arranged tandem, just under the centre of the floor, the platform and superstructure being balanced on

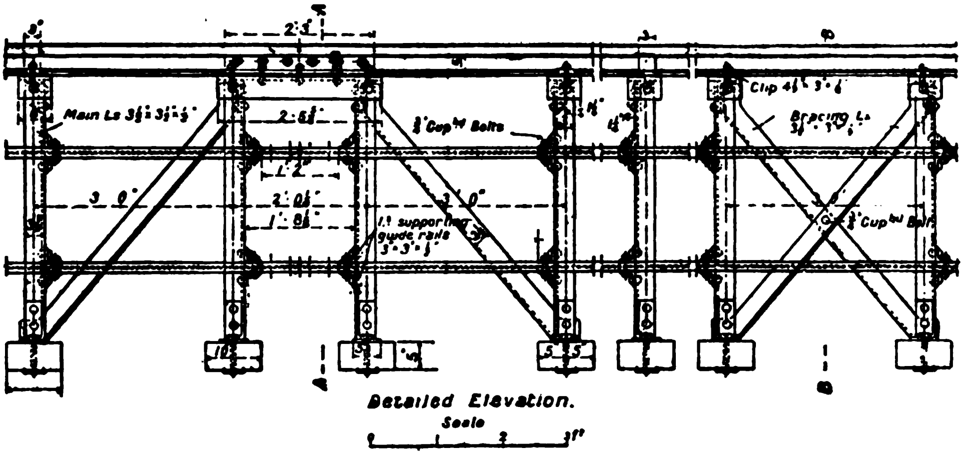


Fig. 6.—Behr System.

them. The car is balanced on the single rail, the wheels being of the grooved pattern. So accurately are the weights adjusted that a slight lurch of the body will sway the car from side to side. At first some apprehension was expressed that in going around curves the centrifugal motion of the car would impose too great a strain on the bents, but this fear has proved wholly groundless. By allowing for the centrifugal force by the slant toward the inner side of the circle which is accomplished on ordinary roads by raising the outer rail the weight is thrown off the bents and approximately equalized. A road of this character is now in operation between Washington, D. C., and Wildwood Park, Md., a distance of forty miles.

The English monorail known as the Behr System, here illustrated, has been in operation for a number of years at Ballybunnion, Ireland, and was successfully tested by the Belgian government, securing a speed of 83 miles per hour with a car weighing 70 tons. In 1901 and 1902 the English parliament granted Mr. Behr's company the right to construct a road between Manchester and Liverpool, after the plans had been examined and approved by many eminent engineers. The plans as will be seen by the illustrations, appear complicated.

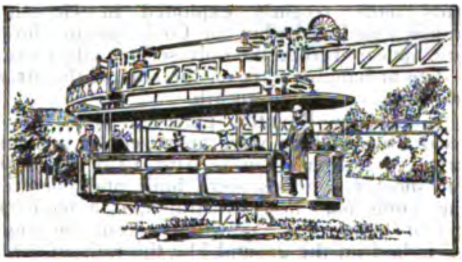


FIG. 7.—Romanoff System.

The road is now being built, and will soon be in operation. It will extend from Manchester to Liverpool, and is patterned after the road which was operated at the Brussels exhibition in 1897, which was three miles long, and on which a speed of 83 miles an hour was frequently made. As this line was very crooked, it was not adapted to as high speed as the Manchester-Liverpool road, which has few curves.

The track is a single rail of the same shape and weight as generally used on steam roads. This rail is fastened at the top of an A-shaped structure made of steel. The structure is riveted to steel ties firmly imbedded in cement and rock ballast. The triangular supports for the rail are only 4 feet high, and one is placed every 3 feet 3 inches. At each side and 18 inches from the ground is placed a light guide rail to keep the moving car in position. The entire weight of the car rests upon large grooved wheels which travel upon the large rail at the top of the framework. As electric motors will be used to propel the train, each of these wheels will be made a "driver." Current is conducted on rails placed upon the ties, but insulated from them.

The car consists of two compartments, one on each side of the structure, and are 60 feet long, weighing four tons each. They will seat 32 passengers, who will sit with their backs to the track. No stops will be made between Manchester and Liverpool, and it is expected to make the trip of 34 miles in 20 minutes, which is just one half the best time now made by the steam road running between these cities. Two tracks will be provided, one for use in each direction, and only passengers, mail and light parcels will be carried.

The monorail idea has been exploited in Germany, France, and Russia in its application to hanging cars, but Germany alone has secured results. A suspended overhead railway system of rapid transit is now in operation between the three manufacturing towns of Vohwinkel, Eberfeld and Barmen, near Cologne, Germany. The road is built on a system of latticed longitudinal girders, one vertical and two horizontal, assembled into the form of an I-section. The main girders form the web of the I, and the lateral girders, which give the requisite lateral stiffness, serve as the top and bottom flanges of the I. Diagonal tie-rods extend from the upper panel points of the central girder to a connection with the chords of the bottom lateral girder. The last mentioned chords consist of steel I-beams, and upon their upper flanges is laid the single T-rail, from which the cars depend and on which they run. The girders, which vary in span from 21 to 33 meters (68.88 feet to 108.24 feet), are carried upon supports varying in structure with the locality where they are used. Where the railway is carried immediately above the Wupper River the A-frame style of pier is used, while in the towns through which the line passes the trusses are carried upon substantial U-frames. The A-frame consists of two rectangular latticed struts, which are united at the top by a rectangular plate yoke.

The supporting structure of the road, including trusses and piers, has an average weight of about 2,000 pounds per yard, which is due primarily to the great length of the girders and unusual height of the supports at Elberfeld. Under more favorable conditions this weight could be reduced.

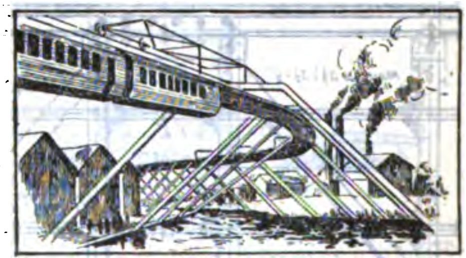


FIG. 8.—Suspension Railway, Barmen, Germany.

The cars are 37.7 feet long, 8.5 high and 6.88 feet wide; are therefore fairly long and narrow, and are slightly tapered at the ends.

They have a seating capacity of fifty, and are built with two side doors opening inwardly, and two auxiliary doors at the ends. The total weight of each car is twelve tons. The cars are freely suspended from two trucks spaced eight meters apart and having a diameter of 0.9 meters. The wheels are mounted in tandem to run on a single rail, and are driven by two electric motors of 36 horse power each, through the medium of transmission gearing. The motor trucks receive current by means of a slipshoe and a contact rail, which is carried on the bottom of the lateral girder, somewhat to the inside of the main supporting beam.

The truck-frames embrace the rail-girders and the rails so closely that a play of seven millimetres is allowed and that derailment is impossible. If a wheel or axle should break the cars would be held up by the frames.

Oscillation of the car is limited by two projections on the lower part of the hook-shaped frame. The cars swing around the curve in a slightly inclined position and spontaneously reassume their normal vertical position when a straight part of the rail is reached. To the passengers the change in equilibrium is imperceptible. Since a sudden change in equilibrium causes an oscillation proportionate to the velocity and the angle determined by the radius of the curve, which oscillation lies within twice the value of this angle, comparatively long transitional bends have been provided by reason of which the equilibrium is gradually changed, with the result that almost inappreciable oscillations are produced.

There are eighteen elevated stations on the line. This elevation was necessary in order not to interfere with street traffic in the towns. The rails run straight through the stations.

A Russian electric engineer named Hippolyte Romanoff has invented a monorailway of some merit. The invention consists of a monorail hanging car as shown here. The rails are supported by T-shaped columns, the carriages being suspended in the air and propelled by wheels running along the rails. These wheels are without flanges, which Romanoff asserts retard speed by clinging to the rails while rounding curves, but are prevented from leaving the rails by means of smaller wheels which grip the rails horizontally.

An electric feed-wire runs parallel with the rail. The cars have three supports each. If the first is broken the second comes into play automatically, and then the third. Should any one of the cars be stopped by an accident or for any reason other than the natural one of pausing at a station, all the cars behind would stop also, thus preventing any rear-end collisions.

In all the various applications of the monorail it has been fully demonstrated to the satisfaction of many of the world's most eminent engineers, that for speed, comfort, safety, and economy it excels any other form of railway yet devised.

Railway Spine. See Neurasthenia, Traumatic.

Railway Surveying. See Surveying.

Railway Systems in the United States. *History.*— From the time of Hero, 2100 years ago, locomotion by steam has been the subject of much thought and experiment, but until Sir Isaac Newton proposed his steam carriage in 1680, there was little or no practical accomplishment. In 1769 the first self-propelled carriage was built by Nicholas Joseph Cagnot, a French army officer. This had two vertical single-action cylinders, and was the first known application of a high-pressure engine. From this time on there was continuous progress in mechanical traction, and although the first locomotives were small and crude, their employment as an agent of transportation marks one of the world's greatest advances. The railways at the beginning were simple tramways equipped with tracks composed of wooden rails. Prior to 1809, Oliver Evans, of Philadelphia, urged repeatedly in public addresses the construction of a passenger railroad from Philadelphia to New York, and in that year attempted to form a company for this purpose. The State of New York, in April 1823, chartered the Delaware & Hudson Canal Company to construct a canal and railroad from the coal fields in Pennsylvania to the Hudson river at Rondout; the railroad, 16 miles long, from Honesdale to Carbondale, to carry coal, was completed in 1829. In 1826, the Quincy railroad in Massachusetts, four miles long, was built to haul granite to the port of Neponset; the rails were of wood, strapped with iron. In 1827, the Mauch Chunk railroad, nine miles long, was built in Pennsylvania to connect coal mines with the Lehigh river; the gauge was three feet seven inches, and the wooden rails were faced with iron. In 1826, the State of New York chartered the Mohawk & Hudson railroad, for freight and passengers, from Albany to Schenectady, 17 miles; work was begun in 1830, and the road was opened for travel in 1831. In 1827, the State of Maryland chartered the Baltimore & Ohio railroad. Work was begun in 1828, and in 1829 the track was finished six miles, and “cars were put upon it for the accommodation of the officers, and to gratify the curious by a ride.” This was the first road in the United States that was opened for the conveyance of passengers; it was finished to Ellicott's Mills, 13 miles, in 1830. The Washington branch was opened to Bladensburg in July, and to Washington in August, 1834. The Charleston & Hamburg railroad, in South Carolina, was chartered in 1827. A locomotive was placed on it in 1830. The road was completed in September 1833, a distance of 135 miles. At that time it was the longest continuous line of railroad in the world. The track of the Baltimore & Ohio consisted of cedar cross-pieces and string-pieces of yellow pine 12 to 24 feet long and six inches square, with iron bars on them. The flanges of the wheels were on the *outside.* After some miles of this kind of road had been made, long granite slabs were substituted for the cedar cross-pieces and pine stringers. “Iron strips were laid for miles and miles on stone curbs.” Before the road had been finished to Point of Rocks in 1832, “wrought-iron rails of the English mode” had been laid on part of the line. Many years passed before any other than flat rails were made in America. All the heavy rails were imported from England. Up to 1843 there were no facilities for the manufacture of heavy iron rails to supply the wants of the 4,185 miles of American railroad then existing, and of a few hundred additional miles then projected. The first heavy rails were rolled in 1844, of the U pattern, at the Mount Savage Iron Works in Maryland. The first T-rails made in America were rolled at the Montour Mill, at Danville, Pa., in 1845. The T-rail, now universally used on American railroads, is generally supposed to be of English origin, but it was invented by Robert L. Stevens, of Hoboken, N. J., in 1830, and was first laid on the Camden & Amboy railroad. It did not come into general use until after 1845. The first made of these rails were only 16 feet in length. The first rails, 30 feet in length, were made at the Cambria Iron Works, at Johnstown, Pa., in 1856. The first 60-foot or double-length rails were rolled at the Edgar Thomson Steel Works, Pennsylvania, in 1875, and that company, in 1876, exhibited a steel rail at the Centennial Exhibition, 120 feet in length, weighing 62 pounds to the yard. See RAIL SECTIONS; RAILS AND STRUCTURAL SHAPES; ALUMINO-THERMICS.

The construction and development of the locomotive has kept pace with railway building in America. The English locomotives were expensive, could not be secured promptly, and were not well adapted to the light rails, steep grades, and sharp curves of the American tracks. Traffic conditions necessitated construction according to designs entirely different from those followed in Great Britain. Starting with Peter Cooper's one-ton locomotive, the *Tom Thumb,* which made its first run in August, 1830, between Baltimore and Ellicott's Mills, the locomotive has passed through every stage of development and enlargement, until now the designer stands between two fires. On the one hand is the motive power department calling for locomotives of ever-increasing tractive power; on the other hand, is the maintenance of way department setting a limit as to the weight of engine allowable. The two demands are largely contradictory, but the balanced compound locomotive gives relief in both directions. The economy gained by compounding gives greater power per unit of weight of engine, and the perfect balancing of the moving parts gives an engine which, compared weight for weight with a single expansion, is very much easier on the track. Traffic requirements are still calling for rolling stock of greater capacity and the monster 400,000-pound locomotive must continue to grow until the highest factor of efficiency and lowest possible ton-mile cost of haulage is reached. See LOCOMOTIVE, THE; LOCOMOTIVE ENGINE; LOCOMOTIVE AND ENGINE INDUSTRY; LOCOMOTIVES, COMPOUND.

The gold of California gave great impetus to railroad projects until the commercial crisis of 1857 and the Civil War seriously interfered. With the return of peace, however, there was a marked revival. The transcontinental route over the Union Pacific and the Central Pacific roads was opened in 1869, and construction then became most active in the Northwestern States. A similar revival followed the crisis of 1873. By 1880 the principal field of activity was in the Southwestern and Rocky Mountain regions and in 10 years, to 1890, the railroad mileage of the country had increased from 93,000 to 164,000 miles. Each section of the country, as it filled up with competing roads, witnessed a period of secret rebates and receiverships and the gradual consolidation of intermediate links into long lines occupying the principal thoroughfares and controlling their own feeders. The consequent stifling of competition early led to the establishment of State commissions and the Interstate Commerce Commission. (See COMMERCE, INTERSTATE.) The vigorous campaign against the Commission has been carried into the Supreme Court with indecisive results — and the war is still on.

Railway Groups.— The railway system of the United States, as a whole, may be divided into groups, each group occupying a distinct section of the country. (See AMERICAN RAILROADS.) This classification gives little information regarding ownership and management. The following tabulation, influenced by community of interest or harmony of action, shows the present progress of groupings of systems. These groups are not antagonistic, but are rather intertwining circles of influence and control, all being irresistibly drawn toward a common centre:

	MILES.
Morgan	26,393
Vanderbilt	20,520
Vanderbilt-Morgan	7,877
Pennsylvania	16,675
Pennsylvania-Vanderbilt-Morgan	4,746
Harriman-Hill-Morgan	20,187
Harriman	23,051
Seaboard Air Line	2,625
Rock Island	14,966
Gould	16,527
Atchinson	8,615
St. Paul	6'682
Minneapolis-St. Louis	3,118
Missouri, Kansas & Texas	3,005
Pere Marquette	2,351
Chicago Great Western	1,464
Wisconsin Central	1,043
Aggregate	179,845

The lines in the Morgan group are the Southern (including the Mobile & Ohio, 874 miles), 9,302 miles; the Atlantic Coast line (including the Louisville & Nashville, 6,133 miles), 10,703 miles; Central of Georgia, 1,877 miles; Chicago, Indianapolis & Louisville, 556 miles; the Lehigh Valley, 1,399, and the Erie, 2,556 miles.

The Vanderbilt group includes the New York Central (with the Lake Shore, 1,411; Michigan Central, 1,653; "Big Four," 2,235; "Nickel Plate," 523, and the Lake Erie & Western, 725 miles), total, 11,079 miles; also Chicago & Northwestern, 8,971 miles.

The Vanderbilt-Morgan lines are the Delaware, Lackawanna & Western, 824 miles; Delaware & Hudson, 966; New York, New Haven & Hartford, 2,037; New York, Ontario & Western, 549; Boston & Maine, 3,298, and the Pittsburg, Bessemer & Lake Erie, 203 miles.

The Pennsylvania group includes the Pennsylvania system, 10,566 miles; the Baltimore & Ohio, 4,397, and the Norfolk & Western, 1,722 miles.

The Pennsylvania-Vanderbilt-Morgan lines are the Chesapeake & Ohio, 1,641 miles; the Reading, 2,145, and Hocking Valley, 960 miles.

The Harriman-Hill-Morgan roads are the Great Northern, 5,888 miles; Northern Pacific, 5,976, and the Burlington, 8,323 miles.

The Harriman group are the Illinois Central, 5,463 miles; Chicago & Alton, 915; Chicago Terminal Transfer, 108; Kansas City Southern, 839; Union Pacific, 6,105; Southern Pacific, 9,621 miles.

The Rock Island group includes the Rock Island, 7,298 miles; St. Louis & San Francisco, 5,663; Chicago & Eastern Illinois, 752; Evansville & Terre Haute, 331, and lines in Texas, 922.

The Gould group includes the Missouri Pacific, 6,006; Texas & Pacific, 1,973; Denver & Rio Grande, 2,460; Saint Louis Southwestern, 1,511; International & Great Northern, 1,130; Wabash, 2,483; Wheeling & Lake Erie, 529; West Virginia Central & Pittsburg, 177, and Western Maryland, 258 miles.

These groups are growing lesser and lesser while the consolidation process is going rapidly on. Should all the interests come together, the gigantic combine will crumble of its own weight, as did many of the railroad systems so elaborately built up 20 years ago. The wisdom of the present may not see the remedy, but earnest thinkers look upon government control or regulation of railways as the only way to establish and maintain equitable relations between the carriers and the people whom they serve.

Ownership.— The actual ownership of American railway securities is vested in about 350,000 people, these holdings ranging from a few shares to more than 40,000. The control of the roads, notwithstanding the ownership through stockholdings distributed among such a large number of individuals, rests with fewer than a score of people representing four or five of the great business houses on Wall street. The following table shows the number of stockholders of record of 30 important railways of the country:

NAME OF COMPANY.	NUMBER OF STOCKHOLDERS IN 1904.
Pennsylvania	44,175
Atchinson, Topeka & Sante Fe	17,823
Union Pacific	14,256
New York Central & Hudson River	11,872
New York, New Haven & Hartford	10,842
Southern	9,572
Illinois Central	9,123
Boston & Albany	8,417
Boston & Maine	7,402
Baltimore & Ohio	7,132
Fitchburg	6,099
Chicago Great Western	5,940
Chicago, Milwaukee & St. Paul	5,832
Lehigh Valley	5,777
Old Colony	5,371
Erie	4,309
Chicago & Northwestern	4,109
Delaware & Hudson	3,819
United New Jersey	3,585
Norfolk & Western	2,911
Denver & Rio Grande	2,910
Pittsburgh, Fort Wayne & Chicago	2,642
Morris & Essex	2,450
New York, Ontario & Western	2,437
Southern Pacific	2,424
Concord & Montreal	2,356
Boston & Lowell	2,168
Northern	2,068
Cleveland & Pitsburgh	2,041
Chicago & Alton	2,039

The following 27 companies each have stockholders ranging between 1,000 and 2,000, as follows:

NAME OF COMPANY.	NUMBER OF STOCKHOLDERS.
Pere Marquette	1,984
Mine Hill & Schuylkill Haven	1,974
Wabash	1,974
Cleveland, Cincinnati, Chicago & St. Louis	1,965
Missouri Pacific	1,861
Louisville & Nashville	1,672
Atlantic & St. Lawrence	1,661
Boston & Providence	1,654
Delaware, Lackawanna & Western	1,575
Cincinnati, Hamilton & Dayton	1,558
St. Louis & San Francisco	1,521
Missouri, Kansas & Texas	1,509
Hocking Valley	1,503
Chesapeake & Ohio	1,478
Vermont & Massachusetts	1,313
Northern Central	1,199
North Pennsylvania	1,100
Rome, Watertown & Ogdensburg	1,094
Huntington & Broad Top	1,072
New York, Lackawanna & Western	1,070
Little Miami	1,064
Rutland	1,058
Chicago, St. Paul, Minneapolis & Omaha	1,045
Utica, Chenango & Susquehanna Valley	1,042
Georgia Railroad	1,038
Philadelphia, Germantown & Morristown	1,035
Wheeling & Lake Erie	1,004

The value of railroad securities held by insurance companies, saving institutions, and educational institutions, exceeds $1,500,000,000, and inasmuch as these fiduciary holders represent large bodies of individuals and some holding companies whose own shares are widely distributed, it is readily seen how materially the business life of the nation is based upon railroad values and how widely diffused is the railroad ownership. See RAILWAY RECEIVERSHIPS AND REORGANIZATIONS; RAILWAY SECURITIES.

Mergers.— The permanent control of a railroad corporation may be accomplished by depositing a majority of its stock with a holding company. This plan is utilized as an indirect means for the consolidation of several companies, by the ostensible sale of sufficient shares of each company to a corporation formed for that specific purpose. This device has been expanded, in the notable instance of the Northern Securities Company, to controlling the operation of rival lines extending from Chicago to the Pacific ocean. In the spring of 1901, the Northern Pacific Railway Company and the Great Northern Railway Company, two roads which were regarded as parallel and competing lines, united in purchasing nearly the entire capital stock of the Chicago, Burlington & Quincy Railway Company, becoming joint sureties for the payment of the bonds of the Chicago, Burlington & Quincy Railway Company, whereby the purchase was accomplished. In November, 1901, the Northern Securities Company was organized under the laws of the State of New Jersey, with a capital stock of $400,000,000. Shortly after its organization that company acquired a large majority of the stock of the Northern Pacific Railway Company, and also a majority of the stock of the Great Northern Railway Company, paying for these stocks with its own stock. A suit was brought by the United States against the Northern Securities Company in the Circuit Court of the United States for the circuit of Minnesota. On 9 April 1903, that court held that all the stock of the Northern Pacific Railway and Great Northern Railway Companies held and owned by the Northern Securities Company was acquired in virtue of a combination or conspiracy in restraint of trade prohibited by the Sherman Anti-trust Act. Its officers, agents, etc., were enjoined from voting the aforesaid stock, or from attempting to vote it at any meeting of the stockholders of either of the railway companies, etc. The decree, however, allowed the Northern Securities Company to return and transfer to the stockholders of the Northern Pacific Railway and Great Northern Railway Companies, respectively, all the shares of stock in either, which the Northern Securities Company had received in exchange for its own stock. An appeal having been taken from this decision to the Supreme Court of the United States, that court on 14 March 1904, affirmed the decision of the lower court. See RAILWAY CONSOLIDATION.

Valuation of Railways.— The aggregate railway capital in the United States on 30 June 1909, as measured by the par value of outstanding securities, was $17,487,868,935, which shows a capital of $73,121 per mile of line, including liabilities. In arriving at the actual valuation of railways, well-defined rules are followed: (1) Inventory valuation applies only to a limited degree. (2) Income valuation is the only true basis of calculating a railroad value. Every item of assets, except those of a distinctly detachable character, is contributory to the general income account and gets its value there. (3) Cost of duplication is only discussed where the line is obviously obsolete in standards of grade and curvature and where the menace of competition at less cost by a better-equipped rival is real. (4) The property accounts of road and franchises are only indirectly considered on the basis of net stock and debt capital per mile of line set against like figures of competitors in the same territory. Questions of actual investment and past costs are practically ignored. The whole consideration is limited to present and future earning power under present and future competitive conditions. Competitive pressure is not supposed to be applied at the maximum at every point; that is, every mile of road is not revalued at an estimated cost of present duplication by a parallel construction under most modern and most favorable conditions. As a practical proposition such duplication is recognized as financially impossible. It could only occur at certain places. Because it may be good enterprise and socially economical to parallel 500 miles of line at present cost of duplication, it does not follow that it is good enterprise and socially economical to do the same for 15,000 miles. The possibility of actual competition for the 500 miles cannot apply with equal force as potential competition to reduce the value of the remaining 14,500 miles.

Gross Income and Its Application.— The total railway capital of the United States in January, 1909, was $17,487,868,935. The gross income of $1,900,846,907, for the year 1905, was applied as follows:

Pay of employees	$775,321,415
Fuel for locomotives	146,509,031
Oil, etc., for locomotives	7,798,642
Taxes	57,849,569
Permanent improvements	41,948,183
Deductions and deficits in weak lines	44,681,341
Locomotives, renewals and repairs	50,000,000
Freight car renewals and repairs	50,000,000
Passenger car renewals and repairs	15,000,000
Bridges	20,000,000
Rails	12,000,000
Ties	20,000,000
Ballast	10,000,000
Buildings	15,000,000
Loss and damages	13,726,508
Payments for injuries to persons	14,052,125
Hire of equipment, car service, etc	20,253,945
Rents for tracks, yards and terminals	19,375,696
Rents for buildings and other property	5,151,803
Train and station supplies	27,856,669
Shop tools and repairs	$8,739,157
Legal expenses	6,783,692
Stationery and printing	11,232,465
Advertising	5,376,368
Miscellaneous expenses	8,791,765
Interest on bonds	277,891,209
Dividends	166,176,586
Surplus income	49,330,740
Total	$1,900,846,907

Equipage and Employees.— Enormous quantities of rolling stock are required to equip the 244,084 miles of railway in the United States. Locomotives number 41,000, of which 10,000 are in passenger service, 24,000 haul freight, and 7,000 are required for special service. There are 37,000 cars needed to move passengers, and 1,600,000 cars to carry freight. (See CAR BUILDING INDUSTRY; STEEL CAR INDUSTRY.) Were all these engines and cars in use at the same time there would be a passenger train for every 21 miles of road in the United States, and a freight train for every nine miles. End to end the passenger equipment would make a solid train 500 miles long. The freight cars and engines would make another train about 9,000 miles long, or nearly three times the entire distance from the Atlantic to the Pacific. A thousand million miles is covered by the various trains during the year — 450,000,000 by passenger trains and 550,000,000 by freights. The mileage of the individual freight cars makes a distance inconceivably great. They run far enough to girdle the earth at the equator each minute, day and night, every day in the year, or an aggregate of 40,000,000 miles a day and over 14,000,000,000 miles a year.

The freight trains of the nation carry 1,250,000,000 tons of goods during the year in an average haul of 135 miles per ton. This means that they transport a total of about 170,000,000,000 ton miles. With every second of time the railroads do enough work to transport a ton of goods 540 miles, or half the distance from New York to Chicago. It would take 25,000,000 teams and their drivers to do as much. The work performed by the railroads, if done in the old way, would require two and a half times as many horses and mules as there are at present in the entire nation, and practically the entire male population over 15 years old. On the whole, so enormous are the demands of our modern civilization, that to feed, clothe, shelter, and provide the various needs and luxuries of the people requires the transporting of a ton of goods 280 miles every week in the year for each family of the nation. The railroads charge the enormous sum of $1,250,000,000 a year for doing this work. Yet this is only three-fourths of a cent for carrying a ton of goods a mile. This estimate does not take account of the passenger service. The railroads take toll amounting to $400,000,000 a year for carrying passengers. But to earn this money they transport 700,000,000 passengers an average of 30 miles each. This is an aggregate of 21,000,000,000 passenger miles a year, or 700 miles with every stroke of the clock. The railroads thus average about two cents a mile for each passenger carried. See RAILWAY TARIFFS; RAILWAY (ELECTRIC) ECONOMICS; RAILWAY INTERCHANGE CAR SERVICE.

To carry on this enormous traffic requires an army of 1,250,000 men, and their yearly pay aggregates $750,000,000. Among these workers are 10,000 presidents, vice-presidents, general managers, and other general officers, and 40,000 general office clerks. There are 35,000 station agents and 110,000 other station men. There are 30,000 telegraph operators. The care of tracks requires 35,000 section foremen and nearly 300,000 track walkers. Watchmen, flagmen, and the like, number 50,000. To keep the trains and buildings in order requires 40,000 machinists, 50,000 carpenters, and 140,000 other shop men. The actual running of the trains requires 225,000 men, or about one in every five of the total number of railroad employees. Of the men 50,000 are engine men and as many more are firemen. There are 35,000 conductors and some 90,000 other trainmen.

Safety Devices.— In the last few years the phenomenal increase in tonnage hauled on American railways has necessitated the purchase of more and better engines and cars of larger capacity, equipped with the best safety devices. Enormous sums have been expended in taking out curves, cutting down grades, laying additional main tracks, putting in new sidings and providing improved terminal facilities. (See RAILWAY ENGINEERING; STREET RAILWAY CONSTRUCTION; RAILWAY PASSENGER STATIONS.) But, notwithstanding all these improvements, many lines find it impossible to handle their business with sufficient dispatch to avoid congestion. This fact has led many progressive American railway managers to realize that if they are to secure the best and most economical returns from the great expenditures made for motive power, car equipment and tracks, suitable means must be provided to enable their trains to move with a minimum of delays and a maximum of safety; and this can only be realized when train orders are supplanted by an up-to-date block system and hand-operated switches by a modern system of interlocking.

The very highest development of the art of signaling has been reached in this country, but no American railway line is nearly so thoroughly equipped with signaling as is the average English line. (See RAILWAY SIGNALS.) The first interlocking plant installed on the London and Northwestern railway was put in service in 1859; 14 years later, in 1873, there were in use on that line alone 13,000 levers. At the same date there was not a single interlocking plant in use in the United States, the first plant in this country having been installed in the year 1874, at Spuyten Duyvil Junction, in New York city. At the present time there are in use on the 1,800 miles of line of the London and Northwestern railway approximately 36,000 interlocked levers, or an average of about 20 levers per mile of line, whereas there are only about 40,000 in use on all lines of the United States, or, approximately, one lever to five miles of line.

The tests recently made at West Seneca, N. Y., have served to demonstrate the net results attained in providing brakes and draft gear fully adequate for service under modern conditions, and to perfect other new devices no less important from an economical and operating standpoint. During the 15 years that have elapsed since the quick-action automatic brake came into general use on freight trains. the average weight of locomotives on drivers has increased from 100,000 to 200,000 pounds, and their draw-bar pull from 25,000 to 50,000 pounds. Within the same period the average freight car capacity has increased from 40,000 pounds to 100,000 pounds; and while in 1888 50 cars in a train was considered a maximum, now 80 is common and 100 by no means rare. Reference to these figures is scarcely needed to emphasize the statement that brake apparatus which met all requirements 15 or 20 years ago is now satisfactory only in inverse proportion to the increased demand made upon it. So far as draft gear is concerned the proposition is self-evident.

Port Differentials.— The Atlantic seaports of New York, viz.: Philadelphia, Baltimore, Newport News, Norfolk, Wilmington, Charleston, Savannah, Brunswick, Jacksonville, Pensacola, Mobile, New Orleans, and Galveston are all competitive with New York and Boston for import trade. The southern ports named contend that, owing to various advantages enjoyed by New York, their business is dependent upon their ability to secure slightly lower inland rates than those to New York. This has long been admitted in practice by the railways, and differences have been made in their favor. Those who support the effort to secure a new law do so because they believe it would result in the prompt abolition of these differentials and so enable Boston and New York to secure a much greater share if not in fact to monopolize the export trade of the country. The principle of a fixed difference being now called into question after 26 years of more or less irregular use speaks volumes for the vitality of the arrangement.

Private Car Lines.— In reference to the agreements between railroad companies and the owners of private cars, it may be accepted as true that such agreements are in the main equitable, and favorable to the public so far as the peculiar circumstances of the case permit. The contentions which the private car lines are now making may have some justification. Perhaps being only indirectly engaged in interstate commerce they may not be subject to the law as it stands. That is a question for judicial determination. But there can be no reasonable doubt that it is within the power of Congress to say that these private car lines shall be regarded as engaged in interstate commerce and thus subjected to the statutes regulating such commerce. It cannot be admitted that private companies may be organized to carry on a regular system of transportation between the States, establishing what rates they please for the service and practising discriminations contrary to law, without being subject to any restraints or control or regulation. To concede that would be to give warrant for monopoly with the privilege of unrestricted abuses. The private car lines are unquestionably engaged in interstate commerce. The cars of these lines transport products between the States and the fact that they are leased to the railroads does not affect the character of their service.

Government Control.— Government control and operation are legally justifiable, if at all, under the commerce clause of the Constitution. But under judicial interpretation the power conferred by that clause is already so swollen as to dwarf almost every other national power. Its original purpose and scope were to prevent hostile commercial legislation by one State as against another and to make all the States but one country in their commercial relations with foreign nations. On this comparatively slight foundation has been built an edifice at sight of which, could it have been brought within their vision, the framers of the Constitution would have stood aghast and which would have doomed the Constitution to inevitable defeat. Under the present construction of the power, liberties and rights of contract once deemed inviolate are subordinated to its exercise and are not even protected by the constitutional amendments adopted for that express purpose. If Congress might lawfully do it, it certainly would be wise for that body to pause before making the experiment of endowing a commission with a jurisdiction which might well make it more powerful than the government itself. That the tendency in that direction would be strong admits of no question. To have even a semblance of competency the commission must have a reasonably permanent tenure of office. Its authority would grow with every year of its life, and before any long time would make its members the most important body of men in the country. No industry could afford not to be in touch with such commission, and every corporation, association, firm, or individual engaged in important commercial or manufacturing enterprise would be compelled to cater to it. In alliance with more or less of the great industries, it would be in a position to influence political conditions and to make itself strongly felt in the choice of Presidents and Congresses and Judges. See RAILWAY ECONOMICS.

The new construction projects now being launched borrow a peculiar, though it may prove an ephemeral, interest from the coincidence that now the academic controversy which has raged for two decades over government regulation of railroad freight rates has suddenly transformed itself into an acutely real legislative issue. The spectacle of railroad presidents dividing their busy hours between signing orders for the construction of main lines and dictating apprehensive protests against destruction by confiscation would be amusing if the subject were a less important one. Apparently the possibility of plenary rate-making power in the hands of a Federal tribunal gives none of them a trembling heart. The country wants rate regulation, but still more does it want new railroads, efficient railroads, and prosperous railroads. See AMERICAN STREET RAILWAYS; TRACTION, ELECTRIC; RAILWAYS, ELEVATED; RAILWAYS, HIGH SPEED; SUBWAYS, ETC.

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Railway Tariffs. The low cost of railway service as compared with other forms of land transportation constitutes the principal element in its superiority, and consequently the efficiency of this means of moving persons and property may be most simply and fully expressed in terms of railway tariff. The amount of the charge for any particular service is the product of a definite rate applicable between the points of origin and destination, or for the distance traversed, and to the commodity or class of passengers carried multiplied by the number of persons or the weight of the freight. Passenger and freight schedules showing the rates charged between all points reached and on all classes of traffic are published by every railway and large numbers of «joint» schedules are also necessary to inform the public as to the rates available over routes formed by two or more connecting railways. Rate schedules have been quite aptly defined as a device for getting back the very large aggregate expenditure necessary for producing this form of transportation in an enormous multitude of small and separate payments. Some appreciation of the truth of this can be obtained from railway statistics. The number of passengers carried by the steam railways of the United States during the 12 months which ended with 30 June 1909 was 891,472,425 and the number of tons of freight 1,556,559,741. The total service in carrying passengers was equivalent to moving 29,109,322,589 passengers one mile and the freight service to moving 218,802,986,929 tons of freight the same distance. The average charge exacted per passenger was 60 cents, or at an average rate of 12.49 mills per mile traversed while the average charge per ton of freight carried was $1.04 or at an average rate of 7.66 mills per mile. The delicacy of adjustment attained is apparent when it is realized that a difference of one mill per passenger and per ton of freight per mile would have amounted to $247,912,300 or a little more than the amount of all railway dividends paid during the year.

Passengers are classified for rate-making purposes according to the quantity of transportation which they purchase and the relation which their travel bears to the development of the territory and traffic tributary to the carrying line. Thus suburban passenger traffic is treated with especial liberality and accorded very low rates because populous and prosperous suburbs contribute profitably to both the passenger and the freight traffic of the lines along which they exist. Suburban passengers are also to be regarded as wholesale and permanent purchasers of transportation and are entitled to special consideration on that account. Similar reasons justify lower rates for commercial travelers and to persons seeking homes in newly opened terri-

YEAR	The United States	Boston & Maine	New York Central & Hudson River	Pennsylvania R.R.	Lake Shore & Michigan Southern	Pittsburg, Fort Wayne & Chicago	Illinois Central	Louisville & Nashville	Chicago, Rock Island & Pacific	Chicago, Milwaukee & Saint Paul	Southern Ry.	Union Pacific
1872	2.521	1.704	1.863	2.379	2.321	....	3.034	3.240	3.229	3.404	3.155	3.730
1877	2.458	1.917	1.953	2.185	2.182	2.192	2.942	3.167	2.772	2.994	3.397	3.140
1882	2.391	1.951	1.808	2.249	2.156	2.024	2.388	2.706	2.505	2.579	2.811	3.300
1887	2.245	1.825	1.989	2.125	2.260	2.255	2.268	2.394	2.328	2.538	....	2.301
1892	2.126	1.809	1.887	2.028	2.183	2.000	2.101	2.448	2.308	2.464	2.682	2.104
1897	2.022	1.764	1.842	1.958	2.108	2.020	1.979	2.254	2.153	2.289	2.372	2.101
1902	1.986	1.764	1.723	1.999	1.828	2.040	1.999	2.319	2.135	2.317	2.244	2.007

tory. The wholesale principle alone accounts for lower charges for parties of two or more, return trip tickets, and for especially long distances. It is also desirable to recognize the degree of elasticity, as to the volume of traffic supplied, of different groups of actual or potential patrons. Those who would not travel at all at the ordinary rates may be induced to travel in large numbers to conventions, etc., if quite low rates are made available for those purposes. Railways can often make these rates with profit to themselves and to their regular patrons provided they can do so without unduly interfering with their ordinary revenue. It is because the ticket-broker or "scalper" interferes with the effort to keep the different classes of travel separate, for rate-making purposes, that his existence renders railway officers reluctant to grant otherwise desirable concessions to special traffic. The profits of these dealers are really commissions for fraudulently transferring passengers from the classes in which they legitimately belong to other classes the members of which are entitled to lower rates; a practice whose possibility obviously tends to restrict the number of low rates offered to the public.

In general, regular, one-way passenger rates over any railway are proportional to the mileage traveled, although differences are made by great systems traversing regions widely varying in respect to density of population and other traffic conditions, and there is a natural tendency toward lowering the average per mile as the distance increases. Excursion rates, commutation, and other special tickets are usually, but not always, sold at rates based in some way upon the single one-way fares. It is commonly known that there has been a very notable and substantially continuous decline in American railway freight rates but the general belief is that there has been no similar movement in passenger rates. As a matter of fact the quality of passenger service is now much higher than it was 30 years ago and little if any real comparison is practicable among rates applying between the same points during different decades. It is worth noting that while passenger charges have either declined or remained stationary the cost of nearly every other incident of travel has advanced. Thus the rate for a single trip between Boston and New York is the same now as during the year in which the Astor House, then the finest hotel in America, was opened, but the standard rate per diem for room and meals at the Astor House was only $2.50 or precisely the figure which is now the minimum price of a room alone at the first-class hotels of New York. Yet no one will deny that the difference in comfort between the hotel of 1848 and that of 1904 is far less than that which separates the passenger journey of the earlier from that of the later year. In 848 a trip from New York to Philadelphia took five hours and cost $4.00; it is now made in two hours and costs $2.50. The rate from Philadelphia to Baltimore has decreased from $3.00 to $2.80 in the same period and the time from six hours to two. The table on the preceding page shows the average receipts in cents and decimals of a cent per passenger mile during the different years indicated for the United States and for several important railways, those for the years during which gold was at a premium having been reduced to their equivalents in gold.

The average in the foregoing for the United States in 1872 represents 44.16 per cent of the mileage then existing in this country, that for 1877 represents 66.77 per cent, that for 1882, 75.27 per cent, and that for 1887, 75.35 per cent. For later years substantially all the railway mileage of the country is represented. If the omitted mileage could be included for the earlier years, it would undoubtedly raise the averages materially.

Freight is also classified for rate-making purposes, although the commodities which move in the greatest volume like grain, coal, ore, cotton, lumber, etc., are usually excluded from the classifications applicable in the regions in which they move most freely and given "special commodity" rates. Owing to the stress of competition partly that among lines of railway connecting the same points of origin with the same destinations, but much more that among the many and often widely separated routes of transportation, water as well as rail, that are allied to different producing regions whose products find entrance to the same or competing markets freight rates are much less likely than passenger rates to be proportioned to the distances traversed or to conform to any arbitrary rule of adjustment. This is especially true of the rates on the great staple articles of commerce to which special commodity rates are commonly applied. For a great many years, however, there have been certain well-established rules of rate-making which have governed nearly all charges within the regions to which they are applied. Thus substantially all through traffic in the regions north of the Ohio and Potomac rivers and east of the Mississippi River, if it crosses, going either to the eastward or to the westward, a line beginning at Toronto and drawn southward through Buffalo, Erie, Pittsburg, Wheeling and Parkersburg to Huntington, W. Va., is charged for at rates derived from the contemporaneous rates on similar traffic shipped between New York and Chicago. This is attained by fixing certain arbitrary differentials which are to be added to or subtracted from the rates to or from New York if the business is destined to or comes from other important cities east of the Alleghany Mountains, by grouping the smaller towns and cities in this region with the larger ones at the same rates and by assigning certain percentages of the Chicago-New York rates to all stations west of the Alleghanies. Thus if the rate on grain from Chicago to New York is 20 cents per 100 pounds, the rate to Philadelphia will be two cents lower or 18 cents and that to Baltimore 17 cents. The same differentials would be used no matter how high or low the grain rate to New York might go. If it should be 25 cents the Philadelphia rate would be 23 and the Baltimore rate 22; if 15, Philadelphia would have a rate of 13 cents and Baltimore one of 12 cents. If a shipment originates at Indianapolis and is destined to New York the rate charged is 93 per cent of the rate which would have been applied had it originated at Chicago. On a shipment from Cincinnati to New York 87 per cent of the Chicago-New York rate is charged, on one from Cleveland, 71 per cent, on one from Detroit 78 per cent, on one from Peoria 110 per cent, and on one from East Saint Louis 116 per cent. Every railway station in this territory has assigned to it a particular percentage. When business originating at a percentage point is destined to some other city, east of the western trunk line termini, than New York, the customary differential is applied to the proper percentage of the Chicago to New York rate. Nearly all rates on traffic to or from points west of the Mississippi River are made by adding to the rates to a point on the east bank of the river the percentage rates from thence to destination. Sometimes, however, the combinations are based upon Chicago or some other percentage point not on the river.

In the territory east of the Mississippi River and south of the Ohio and Potomac Rivers rates are generally made upon the "basing point" system. According to this system certain prominent cities, Atlanta, Augusta, Montgomery, Birmingham, Macon, and others are selected and given relatively low through rates. The carriers contend that these selections are not arbitrarily made, but that they are based upon the competition of rival transportation routes, and commercial conditions of controlling force. In making rates from or to points not designated as basing points the local rates from a basing point to the destination of the traffic are combined with those to the basing point. It is the practice invariably to allow the lowest possible combination on any basing point even though the traffic may not pass through that point. As an example of this method of rate-making the rates to Montgomery and Calhoun, Ala., may be cited. The rate from New York to Montgomery on articles classified as first-class in the Southern classification of freight is $1.14 per 100 pounds, Montgomery being a basing point. The first-class rate from Montgomery to Calhoun is 26 cents per 100. weight and the rate from New York to Calhoun is the sum of these rates or $1.40. The same system is commonly applied even though the destination is nearer the point of origin than the basing point but along a few lines the practice has been abandoned and the rates to the basing points made the maximum while in others the amounts added are arbitraries somewhat lower than the full local rates.

The classification of freight constitutes an important feature of rate-making. Three great classifications are in use throughout the country, while a few roads still maintain their own local classifications and a few state railway commissions impose their own ideas of classification upon the railway traffic over which they have jurisdiction. The Official Classification is applied to nearly all traffic, except that accorded special commodity rates, in the region generally described as east of Lake Michigan, Chicago, and the Mississippi River and north of the Ohio and Potomac rivers. The excepted traffic is that wholly within the State of Illinois where there is a classification promulgated and enforced by the State Railroad and Warehouse Commission and between certain points served by the Boston and Maine Railway. It is also applied to the local traffic of the Chesapeake and Ohio and the Norfolk and Western railways and to certain of the through business exchanged by these companies with their northern connections. The Southern Classification applies generally in the territory south of the Ohio and Potomac rivers and east of the Mississippi River, but many of the railways in this region have their own classifications for local business and the States of North Carolina, Florida, and Georgia have imposed classifications made by legislative authority upon the local business within their several boundaries. The Western Classification applies west of Lake Michigan, Chicago, and the Mississippi River and to all classified traffic to and from the Pacific Coast. There is, however, a state commissioners' classification in Iowa and most of the traffic exchanged with the Pacific Coast is moved on special commodity rates. Each of these classifications has resulted from the consolidation of a large number of earlier classifications the separate existence of which formerly added greatly to the complexity of the railway rate situation in their respective territories. Further consolidation has been advocated and to the superficial view seems in the direction of simplicity, but those fairly cognizant of the diversity of the commercial and traffic conditions respectively governing in the three great divisions of the country covered by the separate classifications now in use are inclined to doubt the wisdom of attempting unduly to hasten the natural trend toward uniformity. The Official Classification has nominally six, but actually eight classes, the Southern has 15 and the Western 10. Each of these classifications provides different ratings for many of the commodities which it includes, according to whether they are shipped in car load quantities or in smaller volume and in all of them the same articles are often accorded different treatment when differently packed or otherwise prepared for shipment. The following table presents interesting data concerning these classifications.

NAME OF CLASSIFICATION	Number of items incl'd	Items rated regardless of quantity shipped		Items given different ratings for carload and less than carload shipments		Items rated for carload shipments only	
		Number	Per cent of total	Number	Per cent of total	Number	Per cent of total
Official	9370	1722	18.37	7492	79.96	156	1.67
Southern	3664	1260	34.39	2332	63.65	72	1.96
Western	8044	2366	29.41	5336	66.34	342	4.25

Discriminations in favor of shipments in car load quantities are eminently just and proper as such shipments are much more economically handled than those in less than carload quantities and their increase means the more effective utilization of the transportation facilities which are available. That there is a tendency toward increasing the number of these discriminations may be seen from the following statement which show the number of items in each classification and the numbers with regard to which such differences were made, for the years 1887 and 1902.

It should be understood that the increase in the number of items classified does not so much indicate an increasing complexity and diversifi-

RATES EASTWARD, CHICAGO TO NEW YORK.

JANUARY 1ST	Flour	Wheat	Corn	Live cattle	Dressed beef	Live hogs	Dressed hogs in refrigerator cars
1867*	90	90	90	..	..	..	..
1872*	65	65	65	..	..	..	..
1877*	30	30	30	..	65	..	..
1882	20	20	20	25	40	25	..
1887	30	30	30	35	65	35	55
1892	25	25	25	28	45	30	45
1897	20	20	20	28	45	30	45
1902	17½	16†	16½‡	28	45	30	45

* Rates for these years are expressed in currency.

† For export; if for domestic consumption, 17½.

‡ For export; if for domestic consumption, 17.

cation of freight traffic, although it represents some growth in that direction, as it does a more complete recognition of the importance to the carriers, and through them to the public, of securing those forms of preparation for shipment which are most convenient in handling. Proper preparation is encouraged by discriminations in the classification which accord more favorable ratings to the same articles when they are packed in the most convenient form than when less desirably prepared.

NAME OF CLASSIFICATION	Number of items		Items given different ratings for shipments in carload and in less than carload quantities			
			1887		1902	
	1887	1902	Number	Per cent of total	Number	Per cent of total
Official	2840	9370	1101	35.60	7492	79.96
Southern	1177	3664	175	14.87	2332	63.65
Western	1672	8044	666	39.83	5336	66.34

Freight rates in the United States have shown a decided and continuous downward tendency and even during the recent years of high prices and corresponding decline in the value of the medium in which charges are paid there has been but little interruption of this tendency. The most important of all changes are those affecting the rates between New York and Chicago because of their use as the basis of other rates, which has been explained, and their relation to the export trade of the country. The following statement shows comparisons between the average rates, in cents per 100 pounds, collected on shipments of the articles named from Chicago to New York in 1867 and in 1902:

COMMODITY	In less than carload quantities		In carload quantities	
	1867	1902	1867	1902
Dry goods	137	75	137	75
Cotton piece goods	137	57	137	57
Boots and shoes	137	75	137	75
Tea	137	75	137	75
Drugs	137	75	137	75
Furniture	137	75	137	65
Agricultural implements	137	57	137	30
Lead	60	35	60	25
Bagging	117	50	117	35
Crockery and earthenware	117	42	117	30
Coffee	117	42	117	25
Starch	117	42	117	25
Sugar	60	39	60	25
Molasses	60	35	60	30
Rice	60	35	60	25

Rates eastward, from Chicago to New York are of similar significance and importance, but while the greater portion of westward traffic is classified the larger part in bulk and value of that moving eastward is carried at special commodity rates. The statement above shows some of the more important, the rates being in cents per 100 pounds and applicable to carload shipments only.

A more complete presentation of the history of railway rates than is practicable here would show reductions in the case of nearly every locality and article of traffic. In the absence of such a presentation the nearest possible approximation to an accurate measure of the downward tendency is to be attained through comparisons of the average receipts per ton per mile. Such comparisons, the averages being expressed in cents and decimals of a cent, appear in the statement below.

The averages for the United States in the foregoing represent 48.27 per cent of the railway mileage of the country for 1872; 60.10 per cent for 1877; 75.41 per cent for 1882; 75.73 per cent for 1887 and substantially the entire mileage

COMPARISON OF AVERAGE RECEIPTS PER TON PER MILE.

YEAR	The United States	Boston & Maine	New York Central & Hudson River	Pennsylvania R.R.	Lake Shore & Michigan Southern	Pittsburg, Fort Wayne & Chicago	Illinois Central	Louisville & Nashville	Chicago Rock Island & Pacific	Chicago, Milwaukee & Saint Paul	Southern Ry.	Union Pacific
1872 *	1.846	3.491	1.422	1.304	1.227	1.264	1.923	2.053	2.229	2.177	4.429	2.390
1877 *	1.286	2.183	.954	.954	.813	1.024	1.719	1.382	1.563	1.949	2.747	2.135
1882 *	1.102	2.405	.738	.874	.628	.752	1.417	1.349	1.281	1.481	1.950	2.102
1887	.984	2.217	.782	.730	.670	.717	1.087	1.075	1.012	1.089	1.920	1.213
1892	.898	1.508	.699	.647	.602	.670	.908	.948	1.055	1.026	1.355	1.081
1897	.798	1.450	.679	.561	.538	.600	.671	.791	.958	1.008	.976	.962
1902	.757	1.119	.632	.590	.503	.610	.622	.744	1.034	.840	.931	.979

*In gold.

for the later years. If the averages of the earlier years could be made to represent all the mileage of those years, they would be higher.

H. T. Newcomb,
Author of 'Railway Economics.'

Railway Traffic. The amount of traffic that can be handled over a railroad has been greatly increased by the use of the telegraph and telephone for dispatching trains, by the adoption of electric and other highly improved signals, and by the possibility of running both passenger and freight trains at higher speeds as the result of having more powerful locomotives and power-brakes operated from the engines. The vast improvements in travel and traffic have resulted quite as much from the progressive adoption of the vehicle to the service to be performed, as from betterments in the road-bed and locomotive.

No matter what the resources of a country may be, the transportation problem is always vital, because without proper transportation facilities markets cannot be made or maintained. The buyer is always anxious for the early receipts of his freights, and countries prosper in proportion to the time saved on freights transported, because time saved means a reduction in expense in the interest account. The railroad must accept lading when accompanied by proper billing instructions, and by law is obligated to transport it in a reasonable manner, giving reasonable service between initial point and final destination, said service to be in accord with the contract, it being additionally recognized that every allowance made in the freight rate is an allowance made in the obligation of the railroad for service, and that reasonable service cannot be rated the same on commodity freights as it is on freights of the higher classes. The entire organization of a railroad is to the end of the movement of the individual car, and every expense is in relation to the earning capacity of the car.

Sources of Revenue.— Steam railroads derive their principal source of revenue from hauling freight. In 1905 the receipts of the Pennsylvania Railroad Company from freight traffic were $100,093,828, while the receipts from passenger traffic were but $27,392,393. This result was accomplished although the gross receipts for hauling the average freight train for a mile were $2,996 at a cost of $2.11, making the net profit about 88 cents. In view of the tendency now to electrify railroads in order that the passenger traffic may be handled with greater speed, with more frequent service of cars and possibly with more safety, and the tendency also in some States to cause a reduction in passenger fares, it becomes a question whether in a few years the passenger business will not be entirely separated from that of carrying freight, at least so far as it may be divorced without endangering charter rights.

Cars.— The use of private cars at the present time may be divided into two general classes, those in which the property of the owner of the cars is transported, and those in case of which one owner is not interested in the contents of the car. In the first case the shipper owns the car, and the car is ordinarily only used for the carriage of the property of the owner. In the second class the cars are usually owned by some private car company, which constructs or purchases the car, keeps it in repair, and leases it to the railroad company. The use of the private car originated in the necessity for special equipment to serve a particular purpose. Live stock, for example, is transported over long distances. In the course of such transportation the animal shrinks in weight and deteriorates in selling quality, besides suffering from want of water, and from crowding and trampling. Hence, the dictates of both interest and humanity require that the animal should be transported as comfortably as possible. And this has lead to many attempts to devise a car in which stock could be fed, watered, and carried without injury. When the inventor of such a car has in the past approached the railroad manager with his invention, he has generally been informed that the railroad had no money with which to experiment, but that if this car when constructed and ready for use would fulfill his representations the railroad would be glad to hire it for a fair rental. This has brought about the organization of a number of companies for the construction and operation of stock cars. The same thing has been true of the refrigerator car. When the necessity for such a car first became evident, various designs were brought forward. Here again railroad managers were reluctant to invest their money in what was largely in the nature of an experiment. The result was that these cars came to be constructed by private companies, which leased the cars to the railroads in the same manner that the stock cars were provided.

Prior to the advent of the steel car, the greatest maximum capacity of a car occupying 30 feet of track was 60,000 pounds, and the weight of this car was approximately 40,000 pounds, so the percentage of live load to dead weight was as 1½ to 1, or of the total weight of a train 60 per cent. was paying load and 40 per cent. dead weight. With the steel car it is possible to load 100,000 pounds, or 50 tons, on a car weighing 38,000 pounds, or 19 tons, which increases the proportion of paying load to dead weight to 2½ to 1, or to approximately 75 per cent. of total weight. Nor is the increase in percentage of weight per car the only benefit derived from the increased capacity. The 50-ton car occupies no more space upon the track than the 30-ton car, so the actual capacity of sidings and track room is almost double. Naturally, an increase in weight of rails and increase in hauling capacity of locomotives follows the increased tonnage capacity of the cars. The train load is increased not only by increasing the capacity of the cars, but by diminishing the number of empty cars hauled and by endeavoring to load all cars to their full capacity.

The large capacity car, both coal and box, reduce the cost of operation if properly handled, but so long as light, bulky commodities are shipped, just so long will there be a difference in drawbar-pull on light and heavy cars to contend with even when all cars are of uniform large capacity, and the method of basing on average performance will be as far as ever from securing the proper results, and so long as trains will be made up with light loads at the head end, and heavy loads at the rear, no average plan can make provision for drawbar-pull in such cases, and no proper adjustment can be made unless this factor is taken into consideration. The matter of adjusting the drawbar-pull of each gross of car at each individual location in a train is made feasible and practicable by the aid of a mechanical device, hence it is not a theory but a condition that must be met, and one that the mechanical and operating departments must join hands in overcoming.

At the present time there is a noticeable tendency toward uniformity in couplers and uncoupling attachments and an increase in their strength. The different makes of couplers used are steadily decreasing in number, the new cars turned out being equipped with one or another of four or five standard makes. These new couplers are generally stronger than the old ones, and this improvement in the strength of couplers has reduced the number of defects. Grab irons are receiving much better attention than formerlv and it is now the exception to find cars unequipped with these important safety devices. Loose and bent grab irons are much less frequently found in service, and the practice of using uncoupling levers in lieu of grab irons is also being discontinued.

Operating Expenses.— From the close of the American Civil War to the present time, industrial changes have been more rapid in the United States than anywhere else in the world. Within this period the railway system has grown from 35,000 miles to 217,000 miles; population has more than doubled; wealth has increased more than fourfold; populous cities and sovereign States have grown up where at the beginning was nothing but wilderness. Progress of similar character is going on to-day with undiminished activity. Railways have met this progress by constant adjustments of and reductions in the charges for their services. In 1899 it cost $856,968,999 to operate the railways of the United States; in 1909 the same expenses amounted to $1,599,443,410, an increase of $742,474,411. In 1899 railway labor, exclusive of salaried employes, received $481,264,109; in 1909 the same classes of labor received $988,323,694, an increase of $507,059,585. In 1899 the fuel used by locomotives cost $77,187,344; in 1903 it cost $146,509,031, an increase of $69,321,687. Comparing operating expenses with work done, it appears that in 1899 for every dollar expended for operation the railways were able to carry 17 passengers and 165 tons of freight one mile. In 1909 the passenger mileage for each dollar expended in operation amounted to 17.8 and the freight mileage to 132. Each $1 of operating expenses in 1899 brought in $1.53 in revenue, not including that from miscellaneous services, while each dollar of operating expenses in 1909 brought in only $1.33 in revenue.

Low Rates.— The low rates made by American railroads are the surprise and wonder of foreign railroad men, averaging not more than one-third to one-half of the rates for similar services in other countries under government control and ownership. The foreign railroad officials who have studied this subject here credit these low rates to the sharp, intense competition between railroads having individual liberty of action and desire to build up new territories, forcing the managers and heads of departments to an intensity of research, investigation, and development of economies in cost of service unheard of in countries where the railroads are owned or controlled by the government.

Passenger Service.— The service of transporting passengers differs in many particulars from the freight service. Goods are shipped, while passengers travel of their own volition, controling the time and direction of their movements. One important difference between these branches of the service is that most freight is moved in carloads or trainloads, the start being made when the car or train is loaded, while the passenger business is performed by trains that run on fixed schedules. Some commodities, like milk and fruit, are despatched by trains which run strictly according to schedule, and the collection and distribution of the traffic at the local centres of production or consumption are usually accomplished by *way-freight* trains which have a definite time of arrival and departure. Whether viewed from the standpoint of public benefit or considered with regard to the volume of business done, and profits received by the company, the transportation of freight is the most important service performed by the railroad. As an illustration, showing the percentage of freight earnings, the gross earnings of American railways for the year ending 30th June 1909 were $2,418,677,538. This total comprised earnings from the passenger service amounting to $563,609,342, or 23.32 per cent.; earnings from the freight service amounting to $1,677,614,678, or 69.32 per cent. and other miscellaneous earnings amounting to $177,453,518, or 7.36 per cent.

The passenger service, to a far greater degree than is required in the freight business, must provide for speed, safety, comfort, and convenience. The development of the Pennsylvania Limited is typical of the strides which have taken place with regard to long distance passenger traffic. When first established it left New York 7.55 A.M. and arrived Chicago 9.40 A.M., making the run in 26 hours, 45 minutes. It now leaves New York 10.55 A.M. and arrives Chicago 8.55 A.M., making the run in 22 hours, 50 minutes. Returning, it leaves Chicago 5.30 P.M., making the run in 23 hours. Changes in service accompanied improvements in speed. The Pennsylvania Limited is famous as the first train in the world to afford all the comforts of the home and conveniences of the club. It was also the first train to be vestibuled from end to end. In addition to a high-grade equipment, built especially for this train by the Pullman Company, the train makes special features of its stock quotation service, the barber, bathroom, stenographer, and ladies' maid, which it was the first to provide for the convenience and comfort of patrons.

The service of the Twentieth Century Limited, which is the eighteen-hour train of the New York Central Lines between New York and Chicago, was inaugurated 15 June 1902. Its superior equipment and the splendid physical condition of the roadbed and tracks over which it glides enable its fast time to be made with perfect ease and comfort. During the Columbian Exposition at Chicago in 1893 the New York Central Lines inaugurated the first 20-hour service between Chicago and New York, and from May to November in that year the «Exposition Flyer» maintained its schedule with great exactness. In 1902 the management of this great system of roads, recognizing the nature of the demand for fast service between the two leading commercial centres of the country, evolved the Twentieth Century Limited, which maintained the 20-hour schedule every day in the year. The great success of this train has made it world-famous. Its ability to furnish stenographer, telephone, and telegraph facilities, enabling the transaction of business on the journey, has made it very popular. In response to the numerous demands from its patrons the running time was reduced two hours in June, 1905, making its daily journey of 963 miles in 18 hours, a remarkable achievement. This is a greater number of miles at a higher speed than is run by any other train in the world.

Growth.— The growth of the present railway system of the United States has been little short of marvellous. It was not until 1835 that it reached as much as 1,000 miles, being 1,098 miles in that year. Note the growth since then:

1850	9,021
1860	30,026
1865	35,085
1875	70,096
1885	128,320
1895	181,115
1905	217,328
1910	244,084

There are two very striking facts to note here: First, that in spite of the Civil War, 5,059 miles of railway were built during that unhappy period; second, that in the 10 years following, our railway mileage was doubled.

During the latest year for which statistics are available, the railways of the United States carried, as compared with 1885:

	1885.	1910.
Freight, tons	437,000,000	1,557,000,000
Passengers	351,000,000	891,000,000

Reckoning our population at 93,000,000 in 1910, it is as if every man, woman, and child in the country made nine steam railway trips during the course of that year, and also moved 16½ tons of freight.

The reduction since 1865 of railway freight rates in the United States is also remarkable, as illustrated by the fact that wheat by lake and rail has fallen from 29 cents to 5 cents; by railway only from 46 cents to 11 cents.

Hugh T. Downing,
Mechanical Engineer, New York.

Railway Train Dispatching and Train Handling. The dispatching and handling of trains successfully to meet the demand upon railroads in handling a through passenger service, suburban traffic, freight traffic, U. S. mail, to obtain traffic against competition, and moving such traffic cheaply, promptly, and safely, is an important field of railway operation, and makes great demands upon the operating official.

The engineering department has performed its part in building bridges, laying heavier rail, making stronger track and better roadbed, installing interlocking plants and block signaling, and providing for heavy engines.

The mechanical department has met the requirements in designing large engines of greater power, enabling heavier trains to be handled at greater speed. It would thus seem that the engineering and mechanical departments have reached the limit of their expansion on the lines mentioned. See Railway Construction; Railway Heavy Freight Trains; Railway Traffic.

This brings the situation to the operating official, putting in his hands the opportunity and responsibility of getting the very best results from the facilities and equipment at his command. The handling of through passenger trains requires that the trains should have assigned an engine capable of making the schedule with 20 per cent reserve power, thus being able to overcome unexpected delays. As few stops as possible should be scheduled for such trains. If traffic is sufficient, at intermediate points a local train should be run ahead of the through train to carry passengers to a point where these stops are made so passengers can have the opportunity of taking the through trains. Express and mail should be handled on through locals and mail trains provided for such service. If the scheduled trains should at times require more cars than the regular assigned train, instead of adding cars another engine should be provided, or better still, run a second section, loading the first section with all passengers to final destination of train of the initial road, and have the second section do the local work, not letting the first detain the second, thus saving delay also to first section. The public in the territory the through train covers is entitled to have the train on time. This can be accomplished not by sacrificing train schedule to connections, but if necessary by running the train from initial point on time for the passengers on the road served and a second train for the connection. This is not now generally the practice, but the time is quickly coming when this will have to be done by many more roads. Many through trains, specially on single-track roads, are badly detained by the issuing of too many train orders, sometimes giving an engineman eight or ten orders at a station. For enginemen and conductors to understand these orders 12 minutes or more is consumed, and the engineman is handicapped because he is fearful of overlooking an order. If the train is not overloaded and ample power has been provided, it would be much better, if the train is not to exceed 30 minutes late, to give no restrictions by placing orders in favor of freight trains. The engineman would be freer to devote his time to making a good run, and would most likely make up time, and the general movement of the freight trains would be better. The passenger trains should be kept on time and the freight trains will make good runs if they have the proper power and are not overloaded, getting out of stations promptly, and taking advantage of every minute. Freight train employees should be educated to the necessity of giving passenger trains the proper clearance, and that in stormy or foggy weather they cannot make as good a run ahead of or against passenger trains. If they will observe these conditions they will keep out of the way, not only preventing delays but avoiding the possibility of not properly protecting their train. Short time on passenger trains, especially on a road without block signals, has caused serious head-on and rear-end collisions. When excursion trains are run they should be handled with the same promptness, not given any more cars than can be well handled and make a good run, because usually a large number of passengers are taken on at stations. With a long train there is greater delay, passengers are more liable to injury, and the train is in danger. A cheap passenger rate sometimes lends to the handling of too many people at the risk of accident; better run more trains with less cars or not give excursion rates at all. Women and children are generally handled on such trains, thus making the risk greater. Some of the most serious accidents on American railroads have been to excursion trains; sometimes because they are run as sections of a regular train that has not had sections run, and sometimes because the trains were too long and the power furnished poor. The number of trainmen should be increased on excursion trains.

Suburban Trains.—The movement of population in the large cities is constantly toward the towns and villages situated on railroads adjacent thereto. The public consult timetables of different roads, and conclude to locate in such suburban places because the train schedule enables them to go to their business and return home at a certain time. They expect to use certain trains. This being the case timetables should not be changed, otherwise the public will be greatly discommoded unless given other service that will answer their purpose or improve the conditions. Most suburban roads have suburban territory covering zones of 7, 13, 20, and 30 miles. Where a road runs 200 or more trains per day and carries 50,000 passengers per day (as a rule the greatest percentage is handled from 7 to 9 A.M., 5 to 7 P.M.), three or four tracks should be provided; two for express and two for local trains. Usually 70 to 80 per cent of the passengers carried are in the 13-mile zone. As the heavy movement in the morning is toward the city, yards and engine-houses should be provided to hold a large number of coaches and engines at the 13 and 30-mile zones. Small yard and turntable should be provided at the 20-mile zone, where engines can be turned, saving the running of trains a greater distance than the requirements. Where only two tracks are provided the entire distance, and a third track provided three or four miles long (between zones 20 and 13), trains should be run leaving all zones early enough for the early workers; trains leaving 30-mile zone making all stops up to the 20-mile zone, and then express trains from there, or making alternate stops at a few points between zone 20 and destination. Trains should be started from zone 20 making all stops to zone 13, and express from there, or making only two or three alternate stops from zone 13 to destination.

The percentage of passengers moved between zones 13 and 30 being smaller, to save hauling cars not needed beyond zone 13, a coach track should be provided, connected with steam heat in winter, and trains that have left zones 30 and 20 requiring more coaches to pick up passengers where they make stops between zone 13 and destination can do so. The greater movement being from zone 13, instead of having all trains leaving zone 13 make all stops, have first train out make second station stops and next train first station stops, alternating stops from zone 13 to destination; or jump three or four stations into destination. This arrangement to be carried out during the rush hours, thus shortening the time and running semi-express trains.

By having the third track, trains can be started from zone 13 toward destination, and held at end of third track, thus running express trains around the local trains. Trains may have to be scheduled from zone 13, following express trains that make no stops from zone 13 to destination. While a branch road may branch off, say at zone 20, a few throug trains should be run solid on the branch where business will warrant it. When trains are not run through on branch, cars should be attached to trains going to zones 20 or 30, and an engine attached at zone 20, thus saving transfer of passengers or baggage. As many people besides passengers going to their business have baggage it is necessary that a combination baggage car should be provided for each train. Express business should not be handled in the rush hours, except in solid carloads, requiring no work where trains stop. An occasional count should be made of the number of passengers that get on at each station; this will show if the trains as scheduled for stops are serving the people properly. The movement of passengers going to the city may then be controlled, because they come to the trains that are scheduled to stop. A schedule to suit all may not be made, but if the greatest number are taken care of satisfactorily that seems to be the fair way of concluding the service is right.

The roads located in New Jersey that have to make connection with boats have harder conditions to meet than if the destination of the passengers ended on the Jersey shore. Two and three trains are scheduled for a boat; this being the case the boats are scheduled for certain trains and the train schedule must be made or passengers will not reach their destination on time.

The movement of passengers from city to home is more complicated to handle than the movement coming in, because the number of passengers for any train is unknown, when you are hauling heavy trains. This can be overcome usually by having extra cars set on rear of train at starting point, kept locked and used only when necessary. When you have reached the limit of the number of cars you can handle in a train two or three trains can be scheduled same leaving time, scheduling first train to make first stop, 20 miles out, and all stops between zones 20 and 30. Second train making first stop 10 miles out and local stops to 13-mile zone. Third train first stop 7 miles out and all stops from there to 13-mile zone. This keeps the trains separated. Where four trains are run on same schedule, first train goes to 20-mile zone and the three trains following alternate stops to destination so that they are kept out of each other's way. A record of this movement should be made occasionally showing where the passengers get off, and this will show how well the public are being served in the homeward movement.

The locomotives used in suburban service should be the very best, and have at least 20 per cent reserve power. Where trains are making several stops, handling coaches 65 and 70 feet over all, seven cars should be the limit. Ten cars might be handled in express, making a run of 20 miles without a stop; eight cars is better.

As the traffic becomes dense between zone 13 and city, this condition forces more trains from zone 13, and interferes with train movement from zones 20 and 30. To increase handling of passengers at an increased rate the territory from zones 30 and 20 should be handled by having four tracks, so that express trains can be run from zones 30 and 20 without making any intermediate stops between zone 20 and destination, making much quicker time, bringing the population nearer the city, and giving the public an opportunity of obtaining homes at nearby points, thus increasing the passenger haul and increasing earnings with same number of trains run from zones 30 and 20.

Freight traffic gains in proportion with the increase of pasengers hauled. With the coming of trolley competition, the day seems to be not far away, wherever travel is dense, when the ideal timetable will schedule trains leaving initial points at 5, 10, or 15 minute intervals in the rush hours to zones 20 and 30, 3 and 5 minute headway to zones 7 and 13, and 20, 25, and 30 minute headway at other hours of the day to the 30-mile zone increasing the number of trains run as the traffic demands, virtually giving trolley or subway service.

Freight Train Handling. The handling of freight traffic has become a great factor in the railroad business and greatly affects the commercial world. The merchandise movement demands and obtains a regular schedule between our great cities and the Pacific coast. The Pacific is forwarding to the Atlantic fruits that require quick and regular movement. Dressed beef and live stock from the west to the Pacific and to the Atlantic is handled and landed at destination for domestic use and export with precise schedule. The manufacturer, builder, merchant, in fact all mercantile life depends upon the promptness of the handling of traffic, not only for the promotion of trade, but to get the best use of capital invested. Not only is quick traffic to and from the far west necessary, but also to the local points which the road may be serving. The through trains should be built up with cars destined to the points of the connecting line and points beyond, and sufficient trains run to accomplish this. No switching should be required at any intermediate point, changing engines at division points should only be necessary. Another train should run to move the merchandise to the local territory, arriving at destination by 7.00 A. M., serving a territory of 300 miles. A second train should be run serving a territory 400 miles out for second morning delivery. There should be a special train for the movement of coarse freight to the 400-mile point with cars for intermediate points, thus insuring the freight going through without being set out and delayed. If the freight at initial point is not received in time to go out on the day it is loaded, better time is made by holding it over until the next day than by sending it forward in extra trains. The handling of less than carload freight from the great cities has become so heavy that the merchant located 70 or 80 miles out buys with the expectation of getting his freight the next morning. This is done by loading straight cars of less than carload freight for the different towns and villages, running pickup trains to move these cars to destination, and setting the car at freight house ready for delivery to consignee. This has other merits than making schedule time, it saves handling the freight, damage or loss. It also does away with many way freights, and those runs handling car lots and picking up small lots. The car equipment represents a large amount of capital invested, and the number of miles made by a car represents its earning power, it is therefore imperative that the empty cars be moved quickly to point where load can be obtained. This being the case a system is necessary in the building up of trains of empty cars, and this should be accomplished with trains going to the farthest point to save delay in transit. The kind of cars which are in most demand should be sent forward in solid trains, not only to insure prompt movement of trains, but to prevent road power being delayed doing switching. Where passenger train movement is frequent, freight trains running extra should not be started from a terminal too little distance ahead of passenger trains, but should follow them and save delay to power lying on siding, and avoid tiring out the train employees. The cars in way freight and pickup trains should be built up in station order. Where many industries are located and freight traffic locally is heavy, roustabout drills had better be worked covering certain territory, doing the switching for warehouses, team tracks and industries, lining up cars for pickup trains. Roustabout drill engines, when through for the day, can take cars to same yard they started from to be lined up for certain trains.

The telephone is a great auxiliary in the handling of trains if properly used. Locating telephones at blind sidings, at ends of long passing tracks, making communication between conductor and telegraph office, connecting up towers with telephone system so operators can be advised and trains dispatched through instruction from dispatcher to towerman, etc., are all means of saving valuable time and getting desirable results.

We have explained what seems to be the best system in lining up train service, where good power and facilities are furnished. We may have all these things, but if the proper attention is not given to following up the movement of trains the best results will not follow. The train despatcher must keep in close touch with the situation, doing his part to see that a clear track is given to clear fast trains, watching closely the movement of the trains moving in suburban service. Where these trains are running on a close headway if a train should be disabled he must quickly and intelligently grasp the situation by arranging for the handling of the passengers in other trains. In other words, change the schedule to meet conditions. Fast freight trains can be aided by train despatchers keeping inferior class trains advised where to side track. Complete system of reports are necessary, advising of all delays, and these reports must be carefully looked after, following every delay, bringing to the attention of the different departments, or to the employee at fault, their shortcomings, bearing in mind that as eternal vigilance is the price of liberty, so eternal vigilance is necessary on the part of the operating officer who expects to get good results.

C. H. Ketcham,
Superintendent Lackawanna Railroad.

Railway Train Lighting. The expression, "train lighting system," as distinguished from "car lighting system," has come to be used to designate the various electrical systems for lighting steam railway trains. There is, perhaps, no good reason for the distinction, as the greater number of electrical systems are applied to single cars as units. The inventors of the newer methods seem to have had in mind the fact that steam operated trains, not electrically operated cars, were to be lighted. The steam train consists of a number of dependent parts, all going to make a unit. The electric train generally is made up of a number of units, each of which can be operated alone.

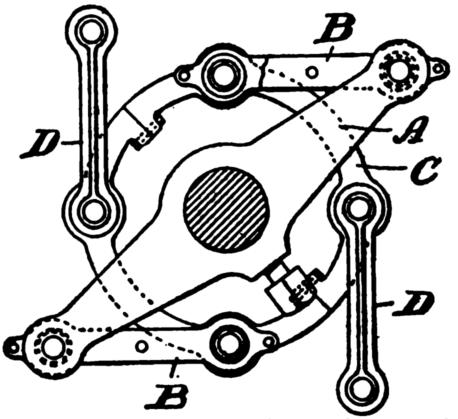

Fig. 1.—Method of driving the dynamo, Sperry-Lyndon train lighting system.

History.—In the early days of railways, candles played an important part in the lighting of the cars. This method was soon replaced by lamps burning various kinds of oil, kerosene being the only one whose use has persisted to the present day. About 1884 the need for better lighting of trains caused a number of railway companies and others to take up the study of the problem presented. As a result two distinctive systems came into use. In one compressed gas stored in tanks under the car is the illuminant. In the other so-called "air gas" is formed by forcing air through a carburetter containing naphtha, or a light hydrocarbon oil and the resulting gas is burned in suitable lamps. One system, belonging to the former class, made use of compressed illuminating gas, such as is used for city and house lighting, but this was not successful on account of the poorer illuminating quality of the gas as compared with oil or air gas.

Pintsch System.—The oil gas system, better known perhaps as the Pintsch system, uses an oil distilled from crude petroleum in suitable retorts. The gas after leaving the retorts is cleaned and compressed and stored in reservoirs, ready for charging the car tanks. Pipes leading from the reservoirs conduct the gas to the train shed and, by means of flexible hose, it is passed into the car tanks. These usually hold several days' supply. The car equipment, in addition to the tanks, consists of a regulating valve for reducing the pressure to a point suitable for the burners, distributing pipes and regenerative burners, that is, burners which heat the gas before burning it, a treatment which increases its illuminating power.

Frost System.—The air-gas system, a type of which is the Frost system, came into use about the same time as the oil gas. In this the carburetter, a tank packed with some absorbent material such as asbestos wicking, is filled with naphtha or gasoline, and air, from the compressed air tanks connected with the air-brake system, is passed through. A reducing valve lowers the pressure to a point suitable for burning. In its passage through the carburetters, the air takes up the hydrocarbon vapor. The mixture is then led to the burner, passing through a heating coil on the way. This coil is placed above the burner and is heated by the latter.

Electricity.—A number of objections have been urged against all such systems of lighting cars. At times a disagreeable odor is given off. The lights can not easily be subdivided and placed so as to get the most effective distribution of light; the lighting is generally accomplished by means of several burners or groups of burners placed along the centre aisle of the car. Any system depending upon a highly inflammable material is a possible source of danger from fire. This is particularly true in case of accidents, the very time when it is most difficult to get away from the danger. Naturally, therefore, railway engineers turned to the electric incandescent system, as it is not only entirely free from all fire risks, but possesses a number of distinct advantages over oil or gas systems. Thus, many small lamps may be arranged so as to give the best results, throwing the light just where it is needed. Compare the usual equipment of 80 incandescent lamps in a Pullman with the 6 or 8 gas lamps usually thought sufficient. The electric lamp gives a soft, white, steady light. There is no odor and no vitiation of the air. On the other hand, it has not been easy to adapt the incandescent electric lighting system to steam railway conditions. One of the first requirements is that the voltage at the lamps must be maintained constant and steady. Another is that the system must call for little attention from the train hands. It is also

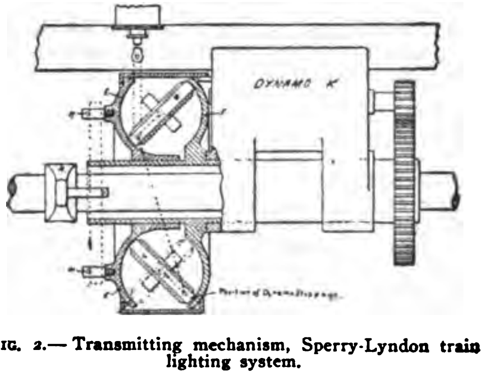

Fig. 2.—Transmitting mechanism, Sperry-Lyndon train lighting system.

highly desirable that the cars be independent, so that they may be detached from the train without putting out the lights. In the first attempts to use the incandescent system on railway trains, storage batteries were placed on each car. A number of roads tried this, but the results were not entirely satisfactory, for while the advantages of the incandescent system were obtained, a number of serious disadvantages developed. The voltage of a storage battery varies considerably from full charge to discharge. Hence regulating lamp resistances were required. These were usually operated by hand. Cars equipped in this way could only run over routes where suitable charging facilities were to be had, and it was found that those responsible for charging the batteries often did not know the proper method of procedure, with the result that the cells deteriorated rapidly. Moreover, charging takes time, as a storage battery can not be filled up as one would fill a gas tank. The car was therefore laid up for several hours every day or two for charging. Some of these objections are not serious under certain conditions, such, for instance, as that of a train which always runs over the same route and lies in the train yard several hours at the end of the run, but it is obvious that the storage battery system lacks flexibility and is not adaptable to all conditions of service, and it now seems to be only a question of time when all passenger cars will be lighted electrically.

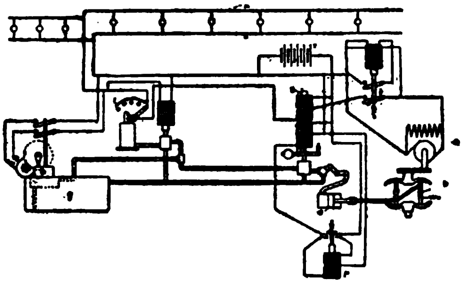

Fig. 3.— The complete system.

The next advance in train lighting consisted in placing a small generating set in the baggage car. Steam was supplied from the locomotive, though an oil engine might be used. Wires were run throughout the train for the lights, and in addition, each car carried a small storage battery to supply the lights should a car be detached temporarily from the train. This system has given good service on certain through trains, but it is not flexible, as the train is the unit, not the cars, and there is some objection to putting the generating plant in the baggage car where it not only takes up space, but requires attention. While better than the simple storage battery equipment, because the batteries can be cared for properly and an improved service can be given, it does not meet the requirements for a completely automatic single car equipment.

Axle-light System.— This requirement for a completely automatic car equipment is met by the so-called «axle-light» systems. In general, these consist of (1) a small dynamo mounted on the car truck and driven by any means from the car axle. (2) a small storage battery to care for the lights while the dynamo is not in service, (3) the usual wiring and lamps, and (4) several automatic devices for charging the battery and maintaining the voltage constant. The usual equipment for a Pullman car consists of a dynamo capable of delivering two and a half kilowatts at the lowest speed, at which it becomes operative, about 80 25-watt incandescent lamps, and a storage battery capable of running the lamps during any ordinary stop. There are a number of systems belonging to this class which have been patented. Certain of them are now (1904) on trial on various roads. The requirements of such a system are: The voltage across the lamps must be constant at all times. The batteries must be kept fully charged and all governing must be done automatically. The axle-light systems differ from each other in the method of controlling the voltage of the dynamo. Assuming the latter to be excited from the storage battery, the strength of the magnetic field will be practically constant, and hence the voltage, unless regulated, will vary directly with the speed of the car. The usual limits within which the dynamo must operate are 14 and 80 miles an hour. Fast trains not infrequently attain speeds of over 70 miles an hour for short times. Below 14 miles an hour the dynamo is cut out of service. The range, however, is nearly six times the lower speed. The methods of governing may be divided into two groups. Those in which the speed ratio of car axle to dynamo armature is kept constant, and those in which the speed of the dynamo is kept constant, independent of the car speed.

Taking up the former class, the dynamo may be driven by a belt, by gears or by a sprocket chain. If the first device is adopted, it is usual to swing the dynamo from the truck and provide a belt-tightening arrangement. Gears and sprocket chains should run in oil. The general operation of these systems starting with car at rest is about as follows: The lights are maintained by the battery until the minimum operating speed has been reached. At that point the voltage across the dynamo has risen to a higher point than that of the battery, and a switch actuated by a solenoid connected across the dynamo, closes the dynamo circuit. The dynamo then takes up the load, supplying the lights and charging the batteries. As the speed changes the dynamo excitation is changed in the opposite sense by an automatic device which may consist of a little motor-driven exciter or a field rheostat actuated by a solenoid, or any other mechanism which will serve the purpose. As the batteries become fully charged their voltage rises and they take less charging current. Since the dynamo must give a voltage higher than that of the batteries, its voltage is too high for the lamps and must be lowered by a resistance in the lamp circuit. This is variable and may be controlled automatically so as to care for all conditions of load. It also serves to regulate the voltage at the lamps during the discharge of the batteries. As the car must be able to run in either direction, the dynamo connections must be reversed with a change in direction of motion in order that it may be connected properly to the battery. This may be accomplished by a pole-changing device operated by the dynamo axle, which throws a switch one way or the other according to the direction of rotation.

A simpler plan is to mount the brush-holder so that it may be shifted easily and to allow the friction of the brushes on the commutator to shift them through a suitable angle so as to keep one brush always positive.

In the second type of axle-light system the speed of the dynamo is maintained nearly constant by a variable speed drive. In one of the early systems of this type the change in driving rate was effected by allowing the belt to slip. In a later type a variable friction drive controlled by the voltage of the system changes the ratio so as to maintain the proper charging current for the batteries. In a well worked out system of this type, recently described, the work of operating the driving mechanism and the lamp resistance is performed by oil maintained under pressure by a small motor and controlled by a compound wound solenoid. In this system the proper rate of battery charging is maintained, the dynamo goes out of service when the batteries are fully charged and no other work is being done and also should the speed of the car exceed 80 miles an hour. In systems belonging to this class a small high speed dynamo may be used, as its speed is nearly constant.

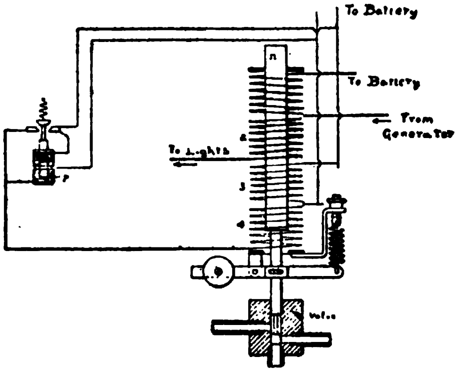

Fig. 4.— Solenoid and Auxiliary Switch, Sperry-Lyndon train lighting system.

Axle-light systems should be entirely automatic and very durable. They are not likely to get much attention and that not of the best. They must be entirely reliable. Such systems are more costly to install than the gas systems, but they are far superior in the results obtained. Although the power required for operation is furnished by the locomotive it is comparatively small and is certainly less than that due to variation in the train resistance due, say, to a slight change in the lubricating oil. Some such system of train lighting will doubtless be adopted largely in the future, at least until the electrically operated train replaces the steam locomotive.

Wm. Hand Browne, Jr.,
Editor 'The Electrical Review.'

Railway Transportation. Railway transportation is concerned with the movement of persons and things. To accomplish this movement the railway companies have organized and developed their passenger, freight, mail, and express services. In carrying passengers and freight by rail the railway corporations supply the entire agency, but in the mail and express services they co-operate with the government and the express companies for whom the railway companies act as carriers. Formerly, the through freight service was to a large extent carried on jointly by the railway companies and corporations called fast freight lines or despatch companies, much as the express business is now conducted; but the work of the auxiliary freight companies has been mostly taken over by the railway organization.

The Freight Service.— The transportation of freight is the most important service performed by the railways. The earnings derived from carrying freight are between three and four times the receipts from the passenger traffic. The dependence of society upon the cheap and unrestricted movements of commodities is much greater than upon rapid and inexpensive travel; because the extent of nearly all forms of industry is definitely circumscribed as regards materials and markets, by the length of the radii of economical transportation of commodities. To travel with comfort and speed is highly convenient, to ship freight long distances with economy and expedition is essential to modern business life.

During the year ending 30 June 1902 the railway companies in the United States reported a total tonnage of 1,200,315,787 tons. This is, however, double the amount of freight actually turned over to the railways by shippers, because much traffic is handled by two or more companies and is reported by each carrier. The tonnage actually received from shippers was 581,822,441. The average distance which each ton was moved was 268 miles; hence the number of tons carried one mile — the ton mileage — was 157,289,370,053. Over half of this enormous traffic, 52.36 per cent, consists of coal, iron ore, and other minerals. Manufactures make up somewhat more than one seventh of the tonnage; forest products furnish one ninth, and agricultural productions nearly one tenth. The remainder of the traffic, about one eighth of the total, comprises animal products, general merchandise, and miscellaneous unclassified commodities. These seven headings include between 9,000 and 10,000 kinds of commodities; and, as it would be utterly confusing to freight agents and shippers for the railways to have a separate charge for carrying each one of this great number of articles between each two termini in our vast country, the goods have been grouped into ten or eleven classes as a basis for fixing rates. The rates in the case of most articles vary according to length of haul, and weight and class of the commodity.

At the present time most freight is handled by one of three classifications: the «official» classification, which prevails east of the Mississippi River and north of the Ohio and Potomac; the «Southern,» which is in force south of the Ohio and Potomac and east of the Mississippi, and the «Western,» which applies west of the Mississippi. Some of the business between the Atlantic and Pacific sections of the United States is handled by the «Trans-continental» classification; and in several States the local, intra-state traffic is required to observe classifications promulgated by the State railway commissions. A single uniform classification for the entire country would be desirable if it were a possibility, because producers, manufacturers, merchants and other shippers could more accurately determine the transportation costs of getting commodities to or from the markets. This would facilitate trade, and would, also, enable the shippers and the government to detect discriminations in railway rates more readily. Moreover, this would simplify the problem of state regulation.

The establishment of a uniform classification does not seem practicable at the present time, although the conditions now prevailing are far better than those were which obtained in 1887 when the Interstate Commerce law went into force. Until that time nearly every large railway had its own classification, there being about 40 different classifications in the present "official" territory. In order to observe the provisions of the act of 1887 prohibiting unreasonable personal and place discriminations, a consolidation of freight classifications was necessary, and the result was the working out of the Official, Southern, and Western groupings. This was followed, during the years 1889 to 1892, by an attempt to amalgamate these three main classifications, and the few minor ones still in use, into one uniform classification. This effort was unsuccessful, because the industrial conditions in the Eastern, Southern and Western sections of the country were so divergent as to make the establishment of a single classification of traffic seem impossible, unless a large number of commodities in each section of the country were omitted from the classification. To make a great number of exemptions would largely defeat the object of a uniform system. Indeed, at the present time, with several classifications, an unfortunately long list of commodities is omitted from the classes. Coal, livestock and certain other kinds of traffic are very properly exempt from classification; but the railway companies are constantly being urged by men who are developing new forms of production or are opening up new resources to give them the advantage of special or "commodity" tariffs. The railways do not favor such exemptions unless the new traffic cannot be secured without the assistance of a special commodity tariff; but the fact that some of the large railway systems have over a thousand commodity tariffs in force shows how potent are the shippers' appeals.

Freight is designated "local" or "through." A shipment between two points on the same line of road is local freight; while through freight is that which comes to the railway company from some other railway, or is that which starting at some point on one line is turned over to some connecting carrier. Through business is that which requires the services of two or more railways. In general, local freight is short distance traffic, and through shipments correspond to long hauls; but this is frequently otherwise, especially since our railway systems have come to include lines many hundred miles long.

Through Freight.— In the management of their through or "joint" traffic the railway companies have made great advances. During the first two decades and a half of railway history each company owned a short trackage, and freight sent between distant points usually had to be rehandled at several junction points, because each company preferred to keep its equipment on its own lines. This method of conducting business was expensive and added greatly to the delays and risks of shipment. Some method of making inter-line shipments without breaking bulk became necessary and the need was largely met by the organization of the "fast freight lines" or freight despatch companies. These organizations date from 1855-6; and, although their original character has changed and several have ceased to exist, they still survive in name. The Union Line, the Empire Line, the Merchants' Despatch, and others of a similar character are organizations with which the public is familiar. At the outset the fast freight lines were managed by corporations distinct from the railway companies. The despatch company solicited freight from shippers, provided its own cars, charged such rates as the conditions of competition permitted, and paid the railway companies for hauling the cars. The nature of the services performed by the fast freight lines may be illustrated by referring to the history of the Empire Transportation Company chartered by the State of Pennsylvania in 1865. This company was organized to increase the business done over the Philadelphia and Erie Railway, which connected Sunbury and Erie, Pa. This road was only a part of one of the through routes between the Atlantic seaboard and the Great Lakes and the oil fields of western Pennsylvania. The Empire Transportation Company, in order "to increase convenience, promptness, and safety, in the transfer of property between inland points . . . and points on the Atlantic slope and seaboard and in foreign countries east thereof," built pipe-lines within the oil regions, constructed terminals at the seaboard and the Great Lakes, and organized transportation companies to operate on the Lakes and over the railway lines west of Pittsburg and Erie. Such an organization as this could perform a useful service. It developed new traffic, it solicited business, it provided itself with rolling stock and thus relieved the railways of supplying specialized equipment at a time when capital was not abundant. The conditions have now changed, however. The railway systems have become so extensive, and their interline relations have been so developed, that the railways are able to perform practically every service which the shipper may require. Every railway will take freight and issue bills of lading for any point in the United States, and, indeed, for many places outside of our country. Most of the despatch companies were brought out by the railways between 1870 and 1880 and converted into "co-operative fast freight lines," which were in reality only joint arrangements among connecting roads to facilitate their through business. Each co-operating road assigned to the joint line a number of cars proportioned to the mileage of its system, and the earnings and expenses of the joint lines were divided proportionately among the constituent companies. These co-operative freight lines thus became essentially an arrangement among certain railways for securing an inexpensive and honest administration of their interline business. This co-operative form of organization put an end to an abuse that was connected with the former independent fast freight line or despatch companies which were frequently owned by the officers and directors of the railways for whom it was profitable to favor the freight line at the expense of the railway corporation.

The consolidation and growth of railway corporations and the development of vast systems are rendering even the co-operative fast freight lines unnecessary. In many cases they continue to exist, but are regarded rather as trademarks of which continued use is made because shippers have become accustomed to sending their freight by certain routes and by particular bills of lading. In keeping the record of the cars, and in settling interline accounts the freight lines are of service to some companies; but the time is probably not far distant when each company will manage all its freight business directly through its own freight department.

A prominent characteristic of the American railway service is the specialization in the freight equipment. For each commodity (like coal, iron ore, petroleum oil, livestock, dressed meats, fresh fruits, etc.) that is shipped regularly and in large quantities there is provided a type of car constructed with reference to the most economical carriage of the traffic. Most of the special-service cars are provided by the railway companies; but a large part of them is owned by the shippers. In times past even greater use was made of private cars than is customary at present; and even now there are probably 125,000 of the shippers' cars, or one seventh of all the freight cars in the United States. The use of private cars will probably decrease in the future, because a large railway corporation doing business in several States can derive more profit from providing all the equipment required for its traffic than from renting private cars for any considerable portion of its business.

When personal discriminations were generally practised the owners of private cars had a great advantage over other shippers, not only because they offered the railways a large tonnage, and could thereby secure a low rate; but also because the car-mileage exacted of the railways by the owners of the private cars was the source of large gains. The private cars usually are devoted to long-distance one-way traffic, which means a disproportionately large mileage for such cars as compared with the others, and that the private cars must be hauled without a paying load half the distance they are moved. Although the customary car-mileage charge has been reduced nearly one half during the past decade the railways continue to prefer shippers to use the railway company's equipment. From the standpoint of government regulation and the prevention of discriminations, the substitution of the carrier's equipment for that owned by the shippers is desirable.

The volume of long-distance traffic and travel in the United States is so great that each railway company is practically obliged to bill freight and to ticket passengers to points on the lines of many other companies. The freight and passenger cars used in handling this joint and through business move freely over the tracks of numerous companies, and an elaborate system of car-records and interline accounts becomes necessary. In Great Britain, ever since 1850, all joint traffic has been handled on way-bills and tickets of a "clearing house," through which the railway companies settle their interline accounts. This method of doing business and settling joint accounts is economical, and makes secret rate cutting on through business practically impossible. There has been much discussion regarding the adoption of the clearing-house method of handling through rail traffic in the United States, but the size of the country is so vast and the number of the companies is so great that a single clearing-house for the entire country seems hardly possible. It might be feasible to operate a clearing-house within each of the half dozen leading territorial groups of American railways; and the progressive consolidation of our railways under a decreasing number of managements will simplify the problem of inaugurating the clearing-house method of managing inter-railway traffic.

The Passenger Service.— In many ways the passenger service differs from that of carrying freight. Freight is handled mainly in car loads or train loads and the car or train is started whenever the cargo is completed. The passenger service, however, is performed by trains that run on fixed schedules quite regardless of the number of passengers that may desire to travel at the time fixed for the train to start. This distinction does not apply in all cases because some kinds of perishable commodities are moved by freight trains that are run in accordance with fixed schedules, but in most instances the distinction holds good. In the passenger service more than in the freight business attention must be paid to speed, safety, comfort and convenience. Although quickness and regularity of service is required of the railways by some shippers the chief demand is for cheap transportation and low rates. Consequently, railway companies are under constant pressure to reduce the cost of handling and hauling commodities. In the development of their passenger service, however, the railways are seeking to increase the speed and safety, and to lessen the discomforts of traveling. Probably, American railway companies have underestimated the demand for cheap passenger fares, but they have unquestionably acted upon the theory that excellence rather than economy has been the demand of the traveling public. The result of following these different aims in the development of the freight and passenger service has been that the average freight train load has nearly doubled since 1890, that the average freight train mile revenue has risen nearly 50 per cent, and that there has been a large decline in freight rates — 23 per cent during the decade 1890–1900; whereas the number of passengers per train is no greater to-day than it was in 1890, and there has been an actual decrease in the revenue per passenger train mile, and there has been only a relatively slight reduction — 7 per cent — in passenger fares since 1890.

Contrary to ordinary belief the American people make comparatively small use of the passenger service offered by the railways. The people of the United Kingdom take nearly twice as many trips each year as the people of the United States do, although there are about twice as many persons in our country as there are in the United Kingdom. The Briton takes 27 rides each year, while the American averages about 7½. As regards the number of trips per year the average per person in the United Kingdom is 27, Belgium 17, Switzerland 15, Germany 12 and the United States 7½. The American travels a few miles more each year than does the inhabitant of any other country except the United Kingdom, but even the people living in such small countries as Germany and France travel almost as many miles annually as does the average person of the United States. One way to show the use made by the people of different countries of the railways for travel is to compare the number of miles traveled per mile of the railways. In Great Britain the number of "passenger miles" per mile of road is about 400,000; in Germany, 343,000; in France, 283,000; and in the United States, 72,000. While it is to be expected that the railways serving such densely populated countries as the United Kingdom, Germany and France will have a greater passenger traffic per mile of line than will the railways in a relatively sparsely settled country such as the United States, the foregoing figures nevertheless indicate that the American railways can do much to increase travel in the United States.

One method of accomplishing this would be for the American railways to follow the example set by the roads of Europe and to divide passengers into classes. As a matter of fact, there is some classification in the American passenger service, there being the Pullman service above the so-called first class, and a second class; but Pullman cars are run on relatively few trains, and many roads sell no second class tickets. In all European countries there are at least three classes, and in Prussia there are four, besides a separate class for the military. The trend of traffic has been from the upper to the lower grades as the result of increasing travel by the poorer people and the improvements in the comforts to be secured. In the cheaper grades of service the average passenger fares in the Continental countries of Europe are much lower than in the United States. The average receipts per passenger per mile in Prussia are 1.05 cent, in France 1.02, in Hungary about 1.01 cent, and in Austria, about 1 cent. In the United States the average earnings per passenger mile are about 2 cents.

The success which has resulted from the improvement and development of the lower and cheaper grades of service of the European railways suggests that it might be advisable for the railways in the United States to develop a service below that of the ordinary first class day coach, and to make the fares for this inferior service considerably cheaper than those now prevailing. In order to increase their passenger business in a large way it would be necessary for the railways of our country to make its possible for the masses of the people to travel economically. The demand of those who work for small wages is for a cheap service and not for luxury.

To some extent the demand for a cheaper passenger service is being met by the extension of inter-urban electric trolley lines. In many places electric lines have introduced a service cheaper, slower and less comfortable than that offered by the steam lines, and the result has been the development of an enormous volume of local traffic. There are instances of the construction of trolley lines parallel with trunk line railroads and the development of a local traffic 20 times that previously handled by the steam lines. This enormous traffic by trolley has, however, not lessened the travel by steam roads, but has developed a traffic that previously did not exist.

The Express Service.— In the United States a rather sharp distinction is made between express and freight traffic although in each case commodities are transported. Express traffic consists of the articles other than mail matter and personal baggage that are carried on passenger trains. Some express goods are carried in train loads but this is exceptional even at the present time; and occasionally ordinary freight is sent as express in order to secure especially prompt delivery. Express companies also sell money-orders payable at any of their offices and they sometimes collect accounts and execute papers. In foreign countries the express business is conducted either as a part of the freight service of the railways or as a part of the postal service. The United States receives no package for the mails weighing more than four pounds except in the case of a single book, whereas many foreign countries accept packages weighing 11 pounds for carriage by mail. The reason why the American railways do not handle the express business is a historical one. During the first decade of the development of the railways in the United States there was no special organization for handling express business. The patrons of the roads, however, began to send packages from one station to another by entrusting them to the conductors or baggage agents. In 1839 William Harnden began receiving parcels for transmission between New York and Boston. The following year Alvin Adams began to compete with him in the New York and New England business. Harnden then began the express service between the United States and Europe, and 14 years later Harnden, Adams, Thompson and Kinsley consolidated and became the Adams Express Company. The American Express Company grew out of a consolidation which took place in 1850. Wells, Fargo and Company started in 1852, the United States Express Company in 1854, and the other important companies organized soon after that date.

The railway companies of the United States found it convenient and profitable to permit the express companies to organize and develop the parcels service. Each railway corporation makes a contract with an express company giving it a monopoly of the express business over the lines included in the agreement. The railway company furnishes the cars and hauls them for the express company and obtains therefor from 40 to 60 per cent of the total receipts of the express company, the percentage of the total receipts paid to the railway being dependent upon the volume of the express business. In the Eastern States where the traffic is heavy the railways receive 40 per cent. In the contract between the express and railway companies it is usually stipulated that the minimum express charge shall be from 50 to 150 per cent above the rates which would be charged for carrying the articles as ordinary freight. In actual practice the express charges average from 3 to 4 times what the freight rates would be.

The necessity for separate companies to perform the express business is no longer urgent. Indeed it is probable that it would be more profitable for American railway companies to develop their freight service so as to include the collection, carriage and delivery of most of the parcels now handled by the express companies. It is also the opinion of many experts that the time has come for the United States government to include in its mail service the carriage of parcels up to the weight of 10 pounds. By doing this and by perfecting its money-order service the United States government would with profit to itself and convenience to the public perform a large part of the business now done by the express companies.

The Mail Service.—The transportation of the government mails is an important branch of the railway service. Over 8,000,000,000 pieces of mail matter are now handled annually in the United States mails, and the weight of this mail exclusive of the sacks and equipment used in handling it probably exceeds 350,000 tons annually. Although the United States employs steamships, stage coaches and messengers as well as railways to handle its mails, over 86 per cent of the total weight of the mails and equipment is carried by the railways. On 50,000 miles of railways "railway post-offices" or cars equipped as post-offices are run. These cars are in charge of messengers who sort the mail as it is received and place it in special pouches, there being pouches for each city, and usually pouches for each of many sections of the city. On nearly 120,000 miles of railways department mail cars are operated, and on about 20,000 miles of railways the mails are carried in closed pouches usually in the baggage cars. From these figures it would seem that our mail service makes use of nearly 190,000 miles of steam railways. The messengers and crews in charge of the mails travel nearly 250,000,000 miles annually. The railway post-offices have come to be an indispensable feature of the service. The plan of sorting mail while in transit originated in 1862 with William A. Davis, who then fitted up the first railway postal cars. The advantage of using such cars was quickly recognized and they were soon in operation on the principal mail routes. The postal cars now built are from 40 to 60 feet in length, and the government is constantly increasing the number used. To the extent that the distribution of the city mail can be transferred from the post-offices to the postal cars to that extent the delivery of the mails will be expedited. The payments received by the railways for carrying the mails are determined in accordance with Acts of Congress passed in 1873, 1876 and 1878. The basis of payment is the weight of the mails and the distances carried, and, if handled in full-size postal cars, the number of miles such cars are operated. The following table states the amount of payment received by the railways for different weights of the mails and also indicates the equivalent rate per ton per mile for handling this traffic.

RATES BASED ON THE WEIGHT OF THE MAILS.

Average daily weight of mails over whole route	Pay per mile per annum	Rate per ton per mile
200 pounds	$42.75	$1.171
500 pounds	64.12	.702
1,000 pounds	85.50	.468
1,500 pounds	106.87	.390
2,000 pounds	128.25	.351
3,500 pounds	149.62	.234
5,000 pounds	171.00	.187
Each 2,000 pounds in excess of 5,000 pounds.	21.37	.058

The rate per ton mile received by the railways for carrying the mails declines rapidly with the increase of the average daily weight of the mails handled. It is because of this that the railway companies to-day are receiving a lower rate for carrying the mails than they formerly obtained although there has been no change in the provisions of the law for 25 years. The average daily weight of the mails is ascertained by weighing the mails for 30 successive days once in four years. The average of those 30 days is assumed to be the average for each day of the year and the payments for the succeeding four years are based upon those figures. As the amount of mail business increases yearly the railway companies during the latter part of the four year period are not paid for as great a weight as they actually transport. It is estimated that they are paid for 91 or 92 per cent of the weight of the mails carried.

The rates allowed for hauling full-size post-office cars and the equivalent rates per mile run by the cars are shown by the following table:

RATES ALLOWED FOR FULL-SIZE POST-OFFICE CARS.

Length of car	Rate per annum per mile of track	Rate per mile run by cars
40 feet	$25.00	3.424 cents
45 feet	30.00	4.109 cents
50 feet	40.00	5.479 cents
55 to 60 feet	50.00	6.849 cents

It has frequently been charged that the government is unduly liberal in its payments to the railways for carrying the mails. For 20 years the United States has annually paid the railways about one third of the total amount of the postal receipts. When compared with the payments made by other countries this rate is not found to be exceptionally large, and while the remuneration made by the government to the railway companies is ample it can hardly be said to be excessive. See POST AND POSTAGE.

The Organization of the Railway Service.—The agency by which the railway service is performed is a corporation, and on account of the complexity and multiplicity of its duties it is necessarily a highly specialized organization. Like other corporations it has departments and officials for the management of its financial and legal affairs, but in addition to this, it includes a special transportation organization to which four duties are entrusted. One duty is the construction and maintenance in proper condition of the roadway and all necessary structures. The second is to provide and keep in proper repair and to operate the equipment which the traffic may require. The third is to furnish the facilities that will enable passengers and shippers to make use of the transportation service, and the fourth duty is to arrange and adjust the relation of the carrier with its patrons in such a way as to further the interests of both parties. Corresponding with each of these four duties there are separate departments of the service within each of which there is a minute subdivision of duties and responsibilities. From the bottom to the top of the service there runs an unbroken line of responsibility, each employee being responsible to his superior, while the president of the company is under the control of the Board of Directors who must give an account of their management to the stockholders. Corporate organization has reached its highest stage of development in some of the larger railway systems of the United States. The railways in the United States now employ about 1,100,000 men. Unless agriculture be considered as a single industry it is proper to speak of the railway business as the greatest of all the industries. This vast army of railway employees consists to a large extent of skilled laborers who are well paid, are well organized and are steadily adopting higher standards of living. Their influence upon the progress of American labor is far-reaching and altogether beneficial.

Co-operation in the Railway Service.— The railway service is of such a nature that it must be performed by large corporations. Moreover, it is absolutely essential that these corporations should co-operate with each other; not only must they work together in the management of their joint business, but they must also co-operate in the regulation of their competitive traffic. The history of American railway transportation shows conclusively that there must be co-operation among railways if the public is to receive an adequate service at rates that do not unjustly discriminate between persons, places or classes of traffic. The United States and the several State governments have passed many laws prohibiting the co-operation of competitive railways, but such laws have always been inefficient. The necessity for co-operation among railways grows out of the public nature of the service they perform. Railway transportation being a service of a public nature which may be performed directly by the government or by agents authorized by the State, it must be conducted in such a way as to minimize discriminations between persons and localities. For each railway, to compete independently of other roads, by bidding for traffic is to introduce intolerable discriminations. The United States very properly prohibits railways from making unreasonable discriminations, but it makes the mistake of prohibiting that degree of inter-railway co-operation that is necessary for the establishment and maintenance of equitable charges. While the best performance of the railway transportation service and the prevention of discriminations requires that the railways shall be permitted to co-operate, the conclusion is not to be drawn that the railway corporations should be permitted by the government to perform their service and to make their charges without governmental regulation. The proper adjustment of the relation of the carrier and the public requires the supervision of the service by the government, and the correction from time to time of unreasonable discriminations. This is not merely a theoretical statement, but is a deduction fully warranted by the history of railway transportation.

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EMORY R. JOHNSON,
Author of 'American Railway Transportation.'

Railway Yard Switching.— Switching or shunting cars is a term commonly applied in steam railroad yards where freight and passenger trains are prepared for road service and for further distribution of cars at terminal points, the preparation of a train at a terminal point for dispatching to another terminal point and so prepared as to reduce to a minimum extra handling of a train while enroute.

The construction of railroad yards in reference to track arrangements for switching purposes, the equipment of cars and engines, fixed signals, and other facilities requisite to yard operation, have been given much attention by prominent railroad men, and through the periodicals given much publicity, which has done much good in bringing about a higher state of efficiency, but little has been written relative to switching, which, in a general way, means interior operation.

The character of business to be handled regulates the manner in which the switching is performed, therefore, there can be no established rule to govern all yards where switching is done, but taken as a whole, a large per cent. of the rules will apply to all yards and are in effect.

At terminal stations, where trains are received and despatched from the same yard or intermediate yard, the switching is separate and distinct and must, therefore, be divided into two classes as follows:

Make up yard, Trains prepared for road service.	a. Accumulation of loaded and empty cars. b. Inspection and weighing cars. c. Separation of cars into classes. d. Despatch of trains.
Break up yard, cars separated for final delivery.	a. Trains from the road to be switched. b. Inspection and seal record of cars. c. Classification by switching. d. Movement to final destination.

In the make up yard, where trains are prepared for road service and in break up yards, where trains are received from the road, the switching is performed by engines of a type especially adapted to yard service. They are constructed with a short wheel base, which is very essential to the work, as many yard and industry tracks are of very sharp curvature and on which engines of longer wheel base, such as those used on road service, could not move without danger of derailment. They are also of sufficient weight and steam pressure to handle the maximum number of cars received or despatched on one road train.

RAILWAY YARD SWITCHING

In the preparation of a road train, cars are assembled into a receiving yard from various places. Cars are loaded at industries, public team tracks, freight houses, and, after the billing for each loaded car has been prepared, showing the weight, contents, and destination, the cars are collected together by the yard engines, which are assigned to industry and freight house work, and are taken to the receiving yard, where all freight is collected for an outbound movement. The yard, or shifting engines, which perform this and similar work, is all the while under the supervision of the yard master. The crews are composed of the following: one engineman, one stoker, one engine foreman, two helpers. The engine foreman is known as the conductor and the two helpers are known as yard brakemen or yard switchmen. The entire crew is subject to the orders of the engine foreman.

The freight in cars ready for transit, taken from local team tracks, industries, etc., on the road where the switching is done, does not comprise all of the channels from which freight is received, but to the contrary forms only a meagre part of the freight received for shipment. By means of a common interchange or reciprocal arrangement between connecting line roads, which have business relations and are amicable according to a mutual understanding, loaded and empty cars are continually received from connecting roads, which must undergo the same inspection before being switched into road trains as the cars received from other sources.

This freight, being composed of various commodities, live stock, perishable, and dead freight, is then switched into road trains for despatching. It is classified by the switching crews in division or station order, the live stock and perishable freight being given preference and where solid trains of high class freight cannot be run, the train is then filled out by adding additional cars of less important freight, which in railroad circle is termed, "dead freight." This dead freight is added to a train of high class freight until the proper tonnage is acquired to complete a train.

The shifting crews assigned to the make up yards must be men of experience, as a general knowledge of the routing of cars is necessary and can be only acquired by long service and close application to the work, to prevent errors in wrong routing to cars. Cars for the various divisions of a road are switched to tracks which are assigned to a division of a road, the live stock and perishable is switched to tracks assigned for preference trains, dead freight, empty cars, etc., are assigned to other tracks, etc., until there is a complete separation of the freight in building up the road train.

On some terminals, this switching is performed by gravity or hump method, the yard tracks being so constructed as to have an elevation or hump at the head of the make up yard. The cars are detached by the engine foreman singly or in groups, as the classification may require, after which they attain sufficient momentum to gravitate into the yard track to which assigned. Where this method of yard operation is in force, the number of men assigned to an engine is very greatly increased. In yards where heavy business is handled, twenty or more men work with one engine, who bear the title, "Car riders," their duty being to ride the cars into the track to which it is assigned and reduce the momentum of the cars by applying the hand brake to prevent them striking cars already on the tracks with more force than is necessary to have them couple together automatically.

The switch tracks used in the operation of a gravity yard are usually operated by an interlocking plant, the same being located at the summit of the elevation which affords a clear range of vision for the interlocking operators to all of the tracks in use. The duty of the interlocking operator being such as to require him to work in conjunction with the engine crews in disposing of cars to the various tracks assigned. A switching list is first prepared in duplicate and a copy furnished to the interlocking operator and the engine foreman, which indicates cuts or separations to be made in the train. By this method the engine foreman and crew and the interlocking operator work in unison which is necessary to prevent cars from entering tracks which they do not belong. After each cut of cars or yard train has been switched and the cars travel into the tracks to which they are assigned, the car riders, who protect the cars down into the yard, are collected up by the engine which was used to shove the train over the hump. In some yards a special engine is used for this purpose and the men are collected and brought to the summit of the hump to be ready to protect another run of cars. Frequently two yard engines are used in the operation of gravity method of switching, which reduces the amount of delay in the work and increases the number of cars handled without increasing the number of car riders.

The gravity tracks are constructed on a three per cent. grade for a given distance and then are reduced to a two per cent. grade and the yard tracks to one-half of one per cent. grade or just sufficient grade to carry the cars to the desired stopping point.

When a sufficient number of cars shall have been accumulated to make a train of the required tonnage, a road train crew is then called to move the train, consisting of an engineer, fireman, conductor, and two brakemen.

With the growth of the business and the large increase in the number of cars handled at terminal points, it was evident that something better than the switching list for the guidance of the yard crews was necessary and the side carding of cars was inaugurated to designate the routing and the destination of cars, which was found to be practical and is used to quite an extent. Cards of various shapes and colors are used, each color and shape having its meaning, and it is found to be a large factor in facilitating the work, as the yard men soon become accustomed to the cards, which are securely tacked on to the side of the car, and without having to consult the card way bill or the switch list, which accompanies each loaded car, they are able to direct the car to the track to which it belongs, being guided by the color, design, or number of the side card. These side cards, which are put on by the yard clerks, show the contents and destination of the cars and have no value or particular use after the road train is ready to depart, as it is merely a symbol for the guidance of the men when building up a train, thus expediting the work. This system is called "side carding."

In receiving yards where road trains are disposed of, the character of the business, in a measure, is similar in most respects, as far as yard operations is concerned, to yards where trains are made up for road service. A train for the road, arriving from a terminal point, is switched according to its classification and the class of freight included in the train, its destination, etc., regulates, in a measure, the amount of switching to be performed to break up and dispose of the train. If the train consists of loaded cars for freight houses and team track delivery, very little switching is necessary, for the reason that the cars are immediately placed at the freight houses and team tracks for unloading. Carloads of freight for freight houses are unloaded by freight handlers and is stored in the freight house, the consignees, or owners of the goods, being advised of the arrival of such freight, by the freight agent. Cars loaded with commodities other than merchandise, which are unloaded on the team tracks, are handled by the agent and the owners notified in a similar manner, to release the cars.

Trains bearing cars which are through billed or for local industry switching are more difficult to dispose of and require more switching, as additional classification is required. Therefore, a train consisting of the maximum number of cars to complete the tonnage may have twenty or more classifications in order to properly separate the cars and must be separated on to as many tracks as there may be classifications. Yard trains are thus built upon the classification tracks, subsequently delivered by yard engines. The empty equipments, which do not belong to the road performing the switching, are handled the same as loaded cars for connecting line delivery and are disposed of in a like manner.

When a road train arrives at a terminal station, the seals on all loaded cars are carefully inspected by a yard clerk and a record taken to determine if the seals remained intact while the car was in transit and if the contents of the cars remained undisturbed. The train is then inspected by a car repair man for its physical defects, safety appliances, etc., before the train is allowed to be switched. The broken or damaged cars are marked for the repair track and are switched to tracks prepared for that purpose, which is known as the "Rip" or "Shop" tracks. After the repairs have been completed, the cars are again switched into the train for a delivery by a yard engine to the yard or road to which the car may belong. In further preparation of the train, it is sidecarded the same as cars switched into road trains ready for departure. The cards, which are of various color and designs, also bear numbers — the color designates the road or yard to which the car is assigned; the figure designates the number of the freight house or team track to which the car may be assigned; the color of the card designates the connecting line or local district to which the car belongs. All this is of great convenience to the yard employees in switching, as it only becomes necessary for them to observe the color of the card to guide them as to the general direction which the car is to travel. When the cars are moved to auxiliary yards, the cars are placed at the various freight houses or team tracks by yard engines, the yard crews being governed by the figures or notations which may be on the side cards.

In drilling cars from road trains in a break up yard and separating them into classes, they are assigned to tracks in the classification yard, subject to transmission to destination as fast as a yard train has accumulated. When yard trains are delivered to connecting line roads with whom the reciprocal arrangements are in effect, the same engine and crew move a train to the home road on their return, eliminating a light engine movement, which otherwise would be necessary.

Thus the yard power and forces are kept continuously in action day and night, as a mere closing down for a short period would result in yard congestion and delay to freight.

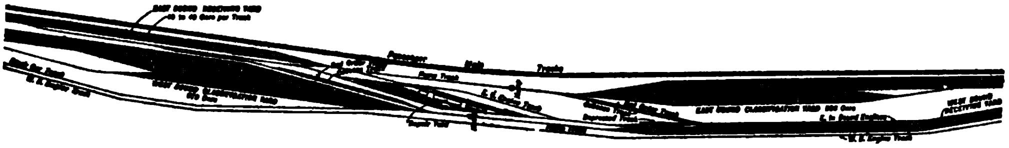
W. J. Prindle,
General Yard Master, Pennsylvania Lines, West.

Railway Yards. A railway yard is a series of tracks and groups of tracks provided at intervals along a line of railway and at its terminal points for the purpose of switching and storing cars, and the distribution of cars and freight. The intervals between the yards are usually from 100 to 200 miles. The yard includes facilities for changing and taking care of locomotives, and at important points there are also facilities for handling passenger cars and trains, but the principal feature is the freight service. The main features of a railway freight yard are to receive trains passing over the road, to separate and classify the cars for their proper destinations, and to put the cars together into trains for forwarding. The quicker these operations are performed and the less time the cars are detained by them, the higher will be the efficiency of operation of the yard.

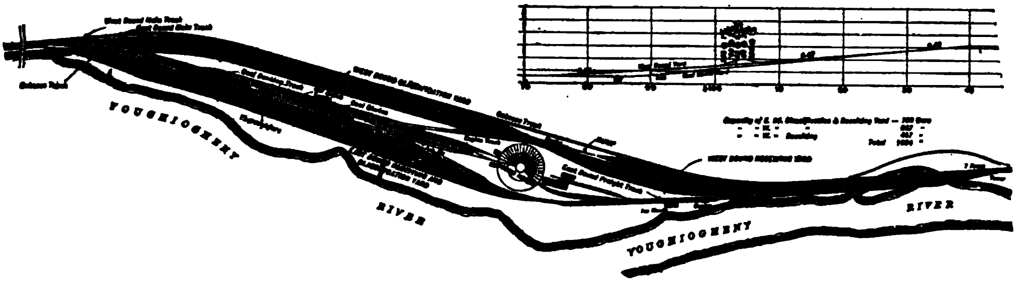
Passenger trains and through freight trains require little attention beyond the changing of engines at division points and the inspection of brakes, wheels, etc., to see that the trains are in safe and proper condition. But general freight trains are composed of cars of various commodities and for various destinations; they have therefore to undergo a series of switching movements at intervals to separate and classify the cars. Cars brought in by local trains from stations along the division tributary to the yard must be classified and distributed for outgoing through and local trains over the next division. At junctions with branches or with other lines of railway the incoming cars must be classified and distributed into similar trains for the different routes. At certain yards, also, it may be necessary to break up the incoming trains and rearrange the cars in lighter trains to be taken over the heavy grades of a mountain division. Some yards provide simply for the redistribution of cars in trains, for forwarding over the next division, or for interchange with connecting railways. Others, as at large terminals and cities, may include the distribution of cars to (and their collection from) freight houses, warehouses, team tracks, factories and industrial establishments, coal and stock yards, coal and ore docks or piers, grain elevators, steamship piers, local or district yards, etc. In addition to handling the loaded cars, it is necessary to collect cars which have been unloaded and to distribute empty cars to points where loads await them.

Design of Yards.— The design of railway yards is a difficult problem, and especially so in the case of the redesign or enlargement of an existing yard. Many large yards have simply grown by gradual and piecemeal enlargements made without regard to the design of the yard as a whole, and are consequently not adapted for systematic and efficient or economical operation. Within the past few years, however, much attention has been paid to this matter, in connection with the general tendency to increase the efficiency and economy of railway operation. A new yard should be designed with regard to the probable growth of traffic, but also with regard to compactness. If a yard is too large, with tracks of unnecessary length, there will be delay and complication in working the cars through the successive groups of tracks, while the aggregate length of the yard will be excessive, causing considerable trouble and delay in the work. If the yard is too small, however, the tracks will be too crowded for rapid and efficient work, involving frequent rehandling of the cars, while incoming trains may interfere with the regular traffic by being held on the main tracks or station tracks until there is accommodation for them in the yard. In very many cases the design of a yard may be limited by the extent in shape of the land available, and one feature of the problem is to obtain a maximum efficiency on a minimum area. This is of increasing importance in and near large cities, and in some cases it may be found advisable to abandon large city yards (occupying land of high value) and to build new outlying yards with connecting lines to city freight stations or small local yards. The capacity of these city stations and yards may be increased by using freighthouses of three or four stories, the cars being handled by elevators. This has been done in a number of cases in Europe.

The various tracks and groups of tracks form together the yard or «general yard,» but each group of tracks for a specific purpose is also called a «yard.» Thus a general yard may comprise receiving, separating, classification, storage, repair, advance, and departure yards. Each of these consists of a series of parallel «body tracks» opening from a diagonal track or «ladder track.» The number and length of body tracks will depend upon the character and amount of traffic. Besides these, there will be special tracks and facilities for such work as supplying ice to refrigerator cars, watering and cleaning stock cars, unloading cars, etc. The separate groups must be so arranged in series that the cars will move continually forward in their several switching movements, all reverse movements being detrimental to the highest efficiency and economy of operation. There will be two separate general yards, for traffic in opposite directions, and special provision must be made for special classes of traffic (coal, cattle, perishable freight, etc.) so that fast-freight trains can be made up rapidly and both these and through trains attended to without interference with the work of switching or moving the ordinary cars. The illustrations show examples of railway yards.

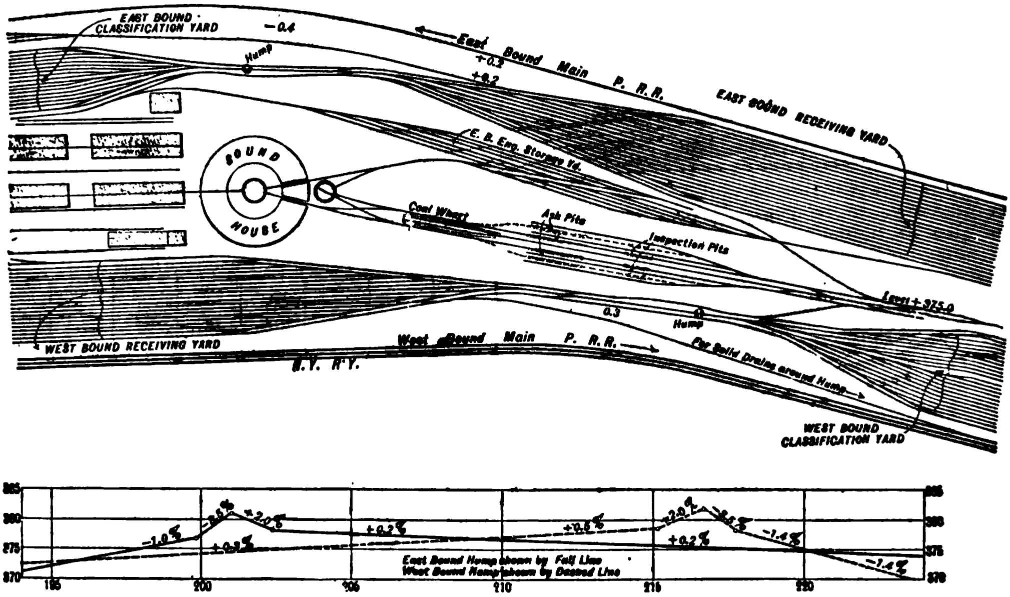


Elkhart Yard, Lake Shore & Michigan Southern Railway.



Connellsville Yard, Baltimore & Ohio Railroad.

Mode of Operation.— When a freight train arrives at a yard, it first enters the receiving yard or track, where the engine and caboose are detached, the work of sorting and distributing the cars being taken in hand by a switching engine and crew. The cars are inspected, and marked as to their disposal, which may include some or all of the following: (1) sent on in through trains over the next division or over some connecting road; (2) distribution to stations along the next division by way or local freight trains; (3) unloaded at the yard; (4) distribution to local freighthouses, grain elevators, factories, coal yards, etc.; (5) held for orders or repairs. The cars are then sent to the separating yard, where those containing the same commodity (grain, lumber, coal, etc.) or those destined for the same point are grouped together on the same tracks. The cars are next passed to the classification yard. If the classification is by commodities, each commodity is sorted into groups; thus a string of grain cars from one track in the separating yard will have the cars of wheat, corn, oats, etc., grouped together on separate tracks in the classification yard. If the classification is by districts, cars for the same district are put together in the order required for delivery at destination. From this yard the strings of cars are drawn to the departure yard to form trains ready to proceed over the road, and the tracks in this yard are frequently provided with air pipes and hose connections for testing the train brakes. An advance yard is sometimes provided to relieve the classification yard when the tracks of the latter become filled. The classification yard is the principal feature, and the separating yard is often omitted. With a large number of tracks in the classification yard, the departure yard is also sometimes dispensed with, except at large yards.



Enola Yard, Fairview, Pa. — Pennsylvania Railroad.

Length of Tracks.— It is very generally assumed that the length of the receiving tracks should be that of the maximum train hauled over the division served by the yard, but the length varies materially for loaded, partly loaded, and empty trains. If the maximum trains are relatively few, it may be better to make the tracks long enough for the average trains, leaving long trains to be split up on two tracks. The disadvantages of very long tracks have been mentioned, but in the receiving yard these may be reduced by putting crossover connections between the tracks at the middle of this yard.

Yard Arrangements.— (1) The classification yard may have the two ladder tracks parallel, so that all the body tracks between them are of the same length; but there is preference for an arrangement of two ladders at each end, forming a V, and making the middle tracks considerably longer than the others. (2) The team yard, in which are placed the cars to be loaded or unloaded by wagons, is best located convenient to the freighthouses. It should be well paved, to facilitate the movements of wagons, and should be equipped with cranes for handling heavy freight, as well as scales for weighing both wagons and cars. The tracks are generally short, holding not more than 15 or 20 cars, for convenience of switching; they are arranged in pairs with paved driveways between the pairs. As a rule the tracks are parallel with the direction of the yard, but in many cases space can be economized by placing them at an angle, the tracks opening from a ladder track. In this way, a number of short-stub tracks may be laid out, facilitating the movement of both cars and teams. This arrangement is also sometimes adopted with freighthouses, the houses taking the place of the driveways. (3) The storage tracks, on which cars are held awaiting orders, should be connected with ladders at each end; otherwise there is a tendency to let cars stay neglected at the end of the track, whence it is difficult to remove them, as all the cars on the track must be switched out. (4) The tracks in the repair yard should be short (for convenience of removing cars when ready), holding 12 to 15 cars. They are generally arranged in pairs, spaced about 16 feet and 40 feet alternately, between centres, so as to enable men to work upon the cars. A narrow gauge track for conveying material may be laid in the 40-foot spaces. It is a good plan to provide separate tracks where cars can have slight repairs attended to without the delay of sending them to the repair yard, or can be held until they can be conveniently removed to that yard. Light repairs may be made on the open tracks, but heavy work is usually best done under cover, with facilities provided for heavy lifting.

Track and Equipment.—A railway yard should be well drained and ballasted, laid with heavy rails and kept in good condition, as a good track greatly facilitates the movement of cars. The maintenance of track under such constant traffic is difficult work, and it is good policy to build substantially in the first place. Scales must be provided for weighing cars, which is done while the cars are in motion, and there should be cranes and mechanical appliances for the handling of heavy freight. The efficient lighting of yards is a difficult problem, and as a rule no system of lighting is used. Electricity is the only practical method, but great care must be taken to avoid long shadows, so that tall poles must be used. The alternations of patches of light with dark fixed and moving shadows may be more confusing than a uniform darkness to which the eyes become more or less accustomed. Telegraph and telephone communication between the main yard office, the outlying offices, and the train dispatcher's office greatly facilitate the speed and smoothness of working.

The main tracks may pass through or around the yard (on one or both sides), and should be connected with the yard only at its ends, the connections being fitted with interlocking switch and signal plants. Within the yard the switches are usually operated by hand, but in some cases the switches of a ladder track are operated by levers from a tower. Mechanical operation is not practicable on a large scale, owing to the length and complication of the connections, and the consequent difficulty of working. At large classification yards, however, compressed air and electricity are occasionally used for operating the switches, which are controlled by push buttons or small levers grouped in an elevated tower.

Switching Cars.— The switching or moving of cars from point to point of the yard is effected by locomotives, but in sorting or classifying them three methods may be used: (1) By drilling; the engine being coupled to the rear of the train and running it to and fro on a "drill track" leading to the ladder. Each car, or cut (group) of cars, is uncoupled in turn and runs from the train onto the ladder and into its proper track. (2) By poling; the engine runs on a track parallel with that on which the train of cars stands, and pushes each car (or cut of cars) onto the ladder track by means of a swinging pole attached to the engine or to a poling car coupled to the engine. This avoids moving the entire train for each switching movement, as is done in drilling. (3) By gravity; the cars being allowed to run down an incline or grade. In each case the momentum of the car carries it along the ladder and into the proper classification track, the switches being opened by the switchmen. A slight grade is sometimes used along the ladder to assist the movements of cars. As a rule, a brakeman rides the car to check its speed and stop it at the proper point, preventing damage to cars and contents by running the cars together at high speed. At some large yards, an engine runs to and fro on a special track to bring these men back, thus saving time.

Gravity Switching.— Where the ground at the site of a yard is on a slope, the cars may be started by a locomotive at the upper end and allowed to run by gravity direct to the classification tracks and thence to the departure tracks without further assistance. This plan has been adopted abroad in some notable cases, but there are very few examples in this country. This system of complete classification of cars into both district and station order entirely by gravity movements was first adopted, in 1873, by Mr. Footner, for the extensive Edge Hill yards of the London & Northwestern Railway, near Liverpool (England). The main part of the yard is on sloping ground, and the cars delivered at the upper end pass through the separating and classification yards (or "gridirons") by gravity, being delivered in proper train order on the departure tracks. From the receiving yard, the cars pass to the separating yards, where each track receives the cars for a particular train. Beyond these are two classification yards through which the cars of each train are passed so as to put them together on the departure track at the foot of the slope in proper order for the train.

Where the natural grades are not suitable for this system, an embankment may be built to form an artificial summit (or "hump" or "camelback"), having the necessary grades to move the cars by gravity. This is said to have been introduced first in Germany, in 1876, and is now very extensively employed in this country. With proper operation this "hump" system will do the work of handling cars through large yards quicker and at less cost than either drilling or poling, besides resulting in less damage to cars and their contents. The "hump" system is generally employed simply for the classification of cars, the embankment and summit being located on the line of the tracks leading from the receiving yard to the classification yard. There is an easy ascending grade on the side approached from the receiving yard in order to close the cars together and so facilitate uncoupling. Beyond the summit there is a short steep descending grade followed by easier grades continuing along the ladder track to the classification tracks. A train of cars is slowly pushed up to the summit, each car or cut of cars being uncoupled and acquiring an impetus on the short steep down grade which is sufficient to run it into the proper classification track. The grades vary with traffic and climatic conditions, and range from 2½ to 4 per cent. for a distance of about 200 or 300 feet, beyond which a grade of about 1 per cent. extends along the ladder track. Connecting tracks provide for the movement of trains which do not require to be classified. Loaded cars run more easily than empty cars, and all cars run more easily in summer than in winter. Track scales are frequently located on the gravity track, to weigh cars as they pass. The cars on any one track in the classification yard are, as a general thing, not arranged in proper order for handling in trains, so that a considerable amount of shifting approval, but the second gravity movement might be adopted with success for large yards on sloping ground where the cars would move continually by gravity (under control of brakes) instead of having to be pushed up an incline for each summit or gravity track. This would in fact be the continuous gravity system above described.

Buildings.— The buildings required for freight traffic include those for unloading inbound freight from the cars and for loading outbound freight into cars. These are served by driveways for teams. The inbound freight-house must be wide enough to give a proper amount of space for holding freight (50 feet is considered a good width), and usually requires not more than two tracks. The outbound freighthouse should be narrower in order to decrease the amount of trucking (25 feet is considered a good width). There is also sometimes a transfer-house for taking small lots of freight shipped in separate cars for the same point, and transferring them to one car, thus getting one full load and releasing the empty cars for service. Where the buildings have doorways at intervals, cars must be «spotted» or carefully set to bring their doors opposite those of the freighthouse. This may be avoided by putting a platform outside the house, or by making the track side of the house a series of continuous openings, separated only by piers or columns and fitted with rolling or folding-doors. As many as four rows of cars can be loaded by running trucks through the cars, loose bridges being thrown across between their doors. A very common arrangement is to have the inbound and outbound house parallel, with from three to six tracks between them, and a trucking platform between the tracks. At outbound houses where a great number of cars are required, the trucking of the loads from the freighthouse to the cars may be facilitated by arranging a number of stub tracks with the freighthouse at their ends; the tracks are in pairs with covered platforms between the pairs of tracks.

Special Facilities.— At large lake or ocean ports, special facilities are required for transferring freight from cars to lighters, barges, and ships. Sometimes, also, there are yards not accessible bv tracks, but to and from which cars are carried on large floats. For such work open and covered piers, ferry transfer slips, etc., are required. Coal piers and ore piers may also be required, and these usually have the tracks high above the water, being reached by inclines. The cars deliver the coal, etc., into bins or pockets, from which it is discharged by spouts or chutes as required. In some cases, these piers have machines for unloading coal from cars or ore from vessels into cars. Loaded cars for a coal pier are distributed in a yard with a number of short tracks, so that cars with the same grades of coal may be put together. The empty cars may be placed on a smaller number of long tracks, as no sorting is required. At grain elevators, provision must be made for the steady supply of cars without interfering with yard work. For this purpose a special yard or set of tracks for grain cars to be loaded or emptied is often provided.

Passenger Yards.— Passenger cars and trains must be provided for independently of the freight traffic, but these require little switching except at terminal points where trains are made up or broken up. At these points, the passenger car yard requires tracks for storing and handling the cars, and for cleaning them, as well as for light repairs. The cars may be turned on a turntable (independent of the locomotive turntable) or on a Y-track, the latter being specially convenient where entire trains have to be turned, as it saves a considerable amount of time. The storage tracks should be connected with ladder tracks at each end, but car cleaning tracks are often stub or dead-end tracks, with a supply-house across the end. These tracks should be long enough to take a complete train. Tracks are allotted for ordinary cars and for dining, sleeping, parlor, and other special classes of cars. The car-cleaning yard is paved, and is generally supplied with water, steam, gas, and air pipes and electric cables for washing, heating, and lighting, testing the brakes and cleaning the upholstery by the pneumatic process. These pipes are laid between the pairs of tracks.

Locomotive Facilities.— Railways are divided into divisions of 100 to 200 miles in length for operating purposes, and as each division has its own locomotive equipment for both passenger and freight trains it must have facilities for cleaning, storing, and handling the locomotives at the end of their trips. These facilities are usually provided in connection with a freight yard. When an engine has delivered its train into the receiving track of the yard, it is detached and run upon a special track, where it is inspected. It then passes to the ashpit, where the ashpan and grates are cleaned; thence to points where it takes coal, water, and sand. It then usually goes to the engine-house, where it is turned on a turntable before entering the house. Here it is cleaned, has light repairs made, and is held until needed for a return trip. At yards where many engines remain for only a short time before starting on the return trip to their main headquarters, they are sometimes placed on storage tracks in the open air, being sent to the roundhouse only when repairs are required. These storage tracks may be a series of parallel tracks or radial tracks served by a turntable. As a rule the engine-house is in the middle of the yard, and is of circular or segmental form, with tracks radiating from a turntable. Rectangular houses are, however, employed in a number of cases. The caboose of a freight train is changed at the same point as the locomotive, and the yard must have a special arrangement of tracks to receive and store the cabooses; a good arrangement is to put these tracks on a slight grade so that the caboose can be run by gravity to the rear of an outgoing return train.

E. E. R. Tratman,
Author of ‹Railway Track and Track Work.›

Railways, American. See American Railroads; Railway Systems in the United States.

Railways—Early History. Railroads had their practical origin in England as long ago as A.D. 1600, although at that time they were practically a rebirth of an undeveloped idea advanced by the early Romans. As strange as it may seem, our modern steel-ways and luxurious methods of land traveling had their origin in the industrial railways that were first roughly constructed to simplify the transit of coal from the mines in Durham and Northumberland, England, to shipping points on the Tyne and Wear. At first, owing to the very heavy roads, planks were laid along the bottoms of the ruts in the roads. The rough carts, fitted with clumsy wooden wheels or rollers and laden with coal and ore naturally made far better progress than formerly, and it was but a little while later, in 1676, that the planks were placed on the level of the roads with sleepers and cross ties laid underneath at fairly regular intervals. As an old English writer puts it, planks of timber were laid «from the colliery to the river, exactly straight and parallel, and bulky carts were made with four rollers fitting the rails, whereby the carriage was so easy that one horse would draw down four or five chaldron of coals." This method of construction was again improved by filling in the spaces between the "ways" and sleepers with dirt so as not to interfere with the progress of the horses and mules. At this stage of the development of transportation the railroad was known as the "wayleave," and it was found that a horse could easily pull a load of 42 cwt., as against 17 cwt. over the old rough roads. These improved thoroughfares were made across fields, the proprietors of which received a certain rent for the right of way. They underwent little or no mechanical improvement until about 1700, when the wooden beams were clothed with long slips of iron to prevent excessive wear. A more complete improvement, about 1740, was the substitution of cast iron rails fixed in parallel lines on cross wooden sleepers. This construction became general in mining districts by 1775; yet railways did not attract attention as being suitable for general traffic, owing principally to the general interest then displayed in canals.

With the use of cast iron rails the method of traction was improved. Instead of a single large wagon, several smaller wagons were linked together (the germ of the modern train) and flanges were put on the wheels instead of the rails, with a marked increase in traction. Until the invention of a self-acting steam carriage by Richard Trevethick in 1802, the draft continued to be by horses. From 1802 to 1811, numerous patents were taken out leading up to a realization of the fact that locomotives running with smooth wheels on smooth rails could, by friction, draw heavy loads up moderate inclines. In 1814. locomotive power was employed by George Stephenson on the Killingworth Railway with success and was soon afterward applied on the Stockton and Darlington Railway, for which the first Act of Parliament was passed in 1821. This was the first railway to transport passengers, and even with its large measure of success, the locomotive was still a very imperfect machine, with a rate of progress but little faster than the walk of a horse. Acceleration, the main desideratum, was attained by a very simple contrivance, sending the waste steam up the chimney so as to cause a draft in the fire and a resultant rapid generation of steam. By this appliance, with the multi-tubular boiler, the locomotive entered on a new epoch. Notwithstanding the proved feasibility of railroads the public at large were slow to give heed, and in a large measure remained skeptical. The idea of extending railroads for general traffic was perhaps first conceived and urged on the public by Thomas Gray of Nottingham, in 1823 and 1824. In the latter year, Joseph Sanders of Liverpool issued the prospectus of a railway from Liverpool to Manchester, which line, after much opposition, was sanctioned by legislature and opened for traffic in 1830. The success of this line, provided with some of Stephenson's improved locomotives, was immediate and complete and was the beginning of the great commercial enterprise which has since assumed such great importance.

The pioneer American railroad constructed for public use was the Baltimore and Ohio. chartered in 1827, with 13 miles open for traffic in 1830. Five years later, the length of this road was 135 miles. The Charleston and Hamburg railroad in South Carolina was chartered in 1829 with a completion of 137 miles in 1834. The line from Albany to Schenectady, 17 miles in length, was opened in 1831 and five years later Albany and Utica were connected by rail. In 1842 Buffalo was reached. The Columbia Railroad, the first division of the present Pennsylvania Railroad System, connected Philadelphia and Columbia in 1834. This road was built by the State and was a link in the through route, consisting of canals and railroads, connecting Philadelphia with the Ohio River at Pittsburg. The Camden and Amboy, connecting Philadelphia with New York, was chartered in 1830 and completed in 1837. The road from Philadelphia to Baltimore was chartered in 1831 and completed in 1837. The Reading Railroad, built mainly for coal transportation, was chartered in 1833 and opened for traffic in 1838. American locomotives were first built in 1830 and were adapted to the light rails, steep grades, and sharp curves of the American tracks. As traffic conditions changed, the engines, cars, and equipments were made to conform to constantly changing designs. American railway mileage presents an interesting aspect. In 1830 there were 23 miles in use; in 1840 there were 2818 miles; in 1850 there were 9021 miles; in 1860 there were 30,635 miles; in 1870 there were 52,914 miles; in 1880 there were 93,296 miles; in 1890 there were 163,597 miles; and from that date to the present time there have been added about 60,000 miles. The 70,000 miles of railroad built in the United States in a single decade (1880 to 1890) was a marvelous achievement unparalleled in the economic history of any other country in the world.

The railway systems of the United States now comprise about 244,000 miles of line, being about two-fifths of the railway mileage of the world. Estimating the cost of railroad property the world over at $35,000,000,000 it is found that the American Railroads constitute about $12,000,000,000 of this value. See AMERICAN RAILROADS.

Railways, Elevated. Elevated railways presented one of the first potent factors for the solution of the problem of adequate transportation for passengers between points in great cities. The street railway was an earlier factor, but it met the growing inconvenience of congested streets in only a partial degree, affording but temporary relief. In New York, which city possesses the most extensive system of elevated railways in the world, without taking account of the large system in Brooklyn, now a part of the greater city, two means of relieving the streets of some of the burden of passenger traffic began to be considered as long ago as 1860. Two possible solutions presented themselves, one being to carry it underground through tunnels, and the other to carry it over elevated structures. The former met with more favor at the outset, but the first underground project undertaken was speedily abandoned. Considerable ridicule was expended upon the other idea, but in spite of it an elevated railway, with a single track, was built from Battery place through Greenwich street and Ninth avenue to 30th street in 1866 and 1867, and opened to travel on 2 July 1867. It was operated by means of a cable for a short time, when steam locomotives were substituted as motive power. It did not gain popularity as an aid to local travel, and its lack of success caused it to pass into the hands of the sheriff in foreclosure proceedings, and it was sold for the benefit of creditors in 1871.

The West Side (Patented) Elevated Railroad Company, as the corporation which built and operated this pioneer elevated line was named, was succeeded by the New York Elevated Railroad Company, organized 3 Jan. 1872, under a charter granted by the State legislature the year before. A few months later, on 17 June, the Gilbert Elevated Railroad Company, which obtained a charter earlier in that year, was organized to build a line projected by Dr. Rufus H. Gilbert, and which was planned to be a pneumatic tube railway, suspended from lofty arches. For some reason the pneumatic tube idea was abandoned, sustaining at first a modification which, by cutting off the upper half of the tube, made it a mere trough wherein the cars were to run, and it was decided to build a simple elevated railway. Meanwhile there had been not only lack of encouragement for this sort of enterprise, the West Side experiment not having succeeded yet in overcoming popular prejudice, but there was antagonism on the part of property owners who would be affected by the construction of such railways, and there was friction also between the two existing companies. Litigation assisted to complicate and delay matters.

This was the condition of affairs when, in 1875, the State legislature passed what is known as the Husted Act, which provided for a commission to decide as to the necessity for an elevated railway system in New York city, and to determine proper routes. Under this act a commission was appointed by the mayor of the city on 1 July 1875, and after a number of hearings given to all who favored or opposed such a system the decision arrived at was a favorable one. The commissioners announced on 11 December that their work was ended, the routes which they selected being four in number and including respectively Ninth, Sixth, Third and Second avenues. The work of building the lines was assigned to the two companies then existing, and both companies entered at once upon active construction and into equally active litigation, while each was under the necessity of defending the constitutionality of its charter against the attack of citizens, who were determinedly opposed to both. The New York Elevated had extended its line from the South Ferry to 61st street and Ninth avenue in 1876, and had opened it for travel to 59th street. About this time the enterprise enlisted the interest of Cyrus W. Field, who secured a controlling interest in the company in the spring of 1877. The same vigor and determination that marked his connection with the first Atlantic Telegraph Cable was displayed here, and much of the credit for the eventual success which attended the new departure in urban passenger traffic was accorded to him.

Rivalry between the two existing companies had created much business for the courts in the meantime; the constitutionality of their charters was questioned; and there were injunctions and counter-injunctions. The Court of Appeals finally was asked to pass upon the constitutionality of the charters, and it sustained them both by a decision which was unanimous. All injunctions were dissolved and work was pushed forward, not only on the pioneer West Side line, but also upon the Sixth avenue line, which had passed from Dr. Gilbert's control and was known now as the Metropolitan Elevated Road. This line, extending from Rector street to 59th street, was opened 5 June 1878. During 1879 the New York Elevated opened its West Side line to 83d street and constructed its Third avenue line which was opened to 129th street the same year. By this time the new means of travel within the city had commended itself to popular favor to such a degree that the permanency of the enterprise was assured. The Manhattan Elevated Railway Company, organized under a Rapid Transit Act, passed in 1875, and chartered on 29 December of that year, took a lease of the roads owned by both the New York Elevated and the Metropolitan, the lease dating from 1 Feb. 1879. From that time the entire elevated system of New York city, of course not including the Brooklyn system, has been known as the Manhattan Elevated Railway. In 1880 the Ninth avenue line was opened to 155th street; a spur from Chatham Square created an additional terminus for the Third avenue line at City Hall; a branch of the same line at 34th street afforded connection with the Second avenue line, which it crosses below grade, and gave access to the Long Island City Ferry from both lines; and a branch from the Third avenue line at 42d street connected with the Grand Central Railway Station.

Financial difficulties, which had repeatedly beset the companies which had undertaken the development of this already gigantic project were of such magnitude in 1881 that the Manhattan went into the hands of receivers on 14 July. After the difficulties had been straightened out and a reorganization of the company had been effected, each year was marked by extension and improvement of the service until the system became what it is in this year, 1904, an elevated railway consisting of four main lines with branches, its total trackage being 117.14 miles, divided as follows: Main lines and branches, two tracks (each 37.68 miles), 75.36 miles; third track, used for express trains, 15.19 miles; sidings, 26.59 miles. The southern terminus of all the lines is at South Ferry. The Sixth and Ninth avenue lines run through Battery Park to Greenwich street, diverging at Morris street, whence the Sixth avenue line extends through Church street to Murray street, through which it reaches West Broadway; it traverses this thoroughfare to 3d street, passes through 3d street to Sixth avenue, which it follows to its terminus at 59th street, the station being at 58th. A branch running westward through 53d street connects it with the Ninth avenue line. From Morris street the Ninth avenue line runs through Greenwich street to Ninth avenue and through that avenue to 110th street, where a double curve on a very high structure carries it into Eighth avenue, which it follows to the terminus at 155th street. The Second and Third avenue lines are one from

South Ferry to Chatham square. After leaving the ferry they make a sharp turn into Front street; thence through Coenties slip and Hanover square they enter Pearl street, which they follow to and through the New Bowery to Chatham square. They diverge here, the Third avenue line continuing through the Bowery and Third avenue to the Harlem River. At 34th street passengers desiring to reach the Long Island Ferry transfer to a "shuttle" train; and at 42d street another "shuttle" train conveys transfer passengers to the Grand Central station. Trains from City Hall follow the same line, and passengers are transferred at Chatham square to the Second avenue line if they desire it, as well as at the two other transfer stations mentioned. From 129th street at the Harlem River the Third avenue line continues northward, crossing the river by a fine bridge, open also to foot passengers. North of the river the line runs over a private right of way to Third avenue at East 148th street, whence it follows the avenue to Pelham avenue in Fordham, opposite the entrance to St. John's College. Pelham avenue is practically the end of the line, but from this point there is an extension to the Botanical Gardens in Bronx Park, about a half mile farther north. The Second avenue line, after leaving Chatham square, passes through Division, Allen and East 23d streets to Second avenue, through which it continues to the terminus at 129th street and the Harlem River, where passengers going further north transfer to the Third avenue line. Transfers are made at 34th street to either the Long Island Ferry or the Third avenue line via the branch operated on that street. Down-town passengers on either the East or West Side are transferred at South Ferry to up-town trains on the other side. There is also a system of transfers to the surface lines at various points, the transfer costing the passenger three cents extra.

Until 1901 steam locomotives were relied upon entirely for motive power. The matter of substituting electricity began to be agitated in 1885. The first experiments were made with a motor invented by Leo Daft which was kept in service intermittently on the Ninth avenue line, between 14th and 50th streets, from 27 Aug. 1885, until 19 October, when a series of carefully recorded daily runs was made, continuing, except on Sundays and election day, until December 22. The object of this series of runs was to ascertain measurement of coal consumed, etc. The Daft motor derived its power from an insulated third rail. It did not commend itself to the management of the road, and the inventor was unable to make such improvement in it as to secure its adoption. During the latter part of 1886 F. J. Springer operated an electric car successfully on the 34th street branch; and in 1893 an electric locomotive designed by J. B. Enty which was operated by current derived from storage battery, or from a third rail, as might be found necessary, was tried on the same branch with excellent results, but neither of these inventions was regarded as wholly satisfactory. While New York led in adopting elevated railways, it permitted Liverpool, an English city, to be the first in adopting electricity as motive power, the Liverpool Overhead Railway, completed in 1893, adopting it at the outset. In the same year the Intermural Railway, a feature of the Columbian Exposition at Chicago, made successful use of electricity in the operation of its cars. It was not until the spring of 1899 that the Manhattan Railway decided to use electricity, and the change from steam as motive power was made gradually, the first trains operated by electricity being run over the Third avenue line in 1901. It had already come into use on the elevated railways in Brooklyn. The number of passengers carried over the system at the present time aggregates far in excess of 255,000,000 yearly, and the daily average exceeds 700,000. The system is under lease to a corporation named the Interborough Railway Company, chartered May 6, 1902.

Brooklyn, which is now one of the boroughs of New York city, has an extensive elevated railway system which, like that in Manhattan and the Bronx, as the two boroughs comprised within the former limits of New York are called, has grown out of independent enterprises which finally consolidated. The first company was chartered 26 May 1874, under the somewhat peculiar name of the Brooklyn Elevated Silent-Safety Railway, afterward changed to the Brooklyn Elevated Railway. It encountered vicissitudes, chiefly financial, and was reorganized 29 May 1884. Other companies were chartered prior to the date last mentioned, and several later. The Brooklyn Union Elevated Railroad was chartered 30 Jan. 1899, to take over the properties of the Brooklyn Elevated, the Union Elevated, and the Seaside and Brooklyn Bridge Elevated railroads. On 7 July, in the same year, the Kings County Elevated Railroad was chartered to succeed an earlier company of similar name. This company was reorganized in July 1899, absorbing the Fulton Elevated Railway. Early in May 1900 this company acquired the Sea View Railroad, and subsequently it and its acquisitions were merged in the Brooklyn Union Railroad, which is, at the present time, a part of the entire system of elevated and surface lines operated by the Brooklyn Rapid Transit Corporation. The first elevated line in Brooklyn was opened in May 1885. At the present time the various lines comprised in the system have termini at Fulton Ferry, the New York and Brooklyn Bridge, the Broadway Ferry, the Williamsburgh Bridge, Ridgewood, East New York, Woodhaven (where trains follow the New York and Rockaway Beach Railroad to Rockaway), and at 65th Street, Bay Ridge. All trains to and from the bridge either traverse the full length of the bridge to New York, or transfer there to the bridge trains, which were operated formerly by the bridge authorities. The same conditions exist in regard to trains arriving at or leaving the Williamsburgh bridge, except that the authorities have not undertaken at any time the operation of the railways on that structure. The total length of all the elevated lines in Brooklyn is 28.70 miles, with a total trackage of 67.82 miles. Electricity was introduced as motive power in July 1900.

Chicago opened its first elevated railway in October 1893, the pioneer company being the Lake Street Elevated Railway, chartered 24 Aug. 1892. Other companies were subsequently organized, and there has been here, as in New York and Brooklyn, a series of reorganizations and consolidations which have given to the city a large and convenient system. It is operated by electricity.

Boston also has a fine system, which from its opening has been operated by electricity. The building of an elevated railway system was discussed in Boston as early as 1876, but popular opposition and business interests combined successfully for years to defeat any action by the State legislature, which alone was competent to give the necessary authority. The Boston Elevated Railway Company obtained a charter, finally, in 1894, and the road, which was opened to June 1901, was constructed in a little over two years. Its total length is about six and two-thirds miles, and the total trackage, including sidings, is something over 16 miles.

The elevated railway in Liverpool, England, to which reference has been made previously, was completed in 1893, and was the first in the world to use electricity as motive power.

All of the elevated railway systems mentioned thus far are similar to the ordinary railways, the tracks being constructed upon the same principle, but with somewhat lighter rails, and carrying lighter rolling stock. Their distinctive character is derived from the fact that they are carried upon structures of iron or steel, which practically are bridges or viaducts. The proposition to improve them by the introduction of a monorail system has occupied the attention of inventors and railway men for many years. The Meigs single rail system was one of the earliest to attract general attention, and Joe V. Meigs, its inventor, had the backing of such men as the late Gen. Benjamin F. Butler in his efforts to have it approved by the Massachusetts legislature and adopted by the Boston street railway companies. During the winter of 1879-80 a large and successful working model was exhibited to the public in a large loft, with no charge for admission; and in 1886 an experimental railway about one quarter of a mile in length was erected in East Cambridge, with curves, switches, etc., the operation of the system as shown thereby being quite satisfactory to a large proportion of the many people invited to ride upon it. Nevertheless it failed to commend itself fully, and was not considered when Boston finally was ready for elevated railways. The system, as Mr. Meigs once explained it, consists of turning the ordinary double-rail track up on its edge. Horizontally revolving wheels, in contact with the sides of the upper rail, or stringer, furnish the motion, while the car is supported upon rails placed on each side of the lower stringer by wheels having a groove of 45°, giving the wheel contact with both the top and side of the rail as it revolves upon an axle placed at an angle of 45°. The running gear, it is thus shown, bestrides the track, and one of the advantages claimed for the system is that if the supporting wheels should give way in part or altogether the car would remain upright upon the track.

Eugen Langen's monorail system, the main feature of which is the suspension of the cars beneath the running gear, has been in experimental operation since 1900, on a line from Barmen to Elberfeld, Germany. This line is 8.24 miles long, with 18 stations. It is operated electrically, and the consumption of electric power is relatively small, while high speed is quickly attained. On this railroad the cars are so suspended that even in case of a mishap to the carriers they cannot fall.

Howard Hansel Tunis is the inventor of a monorail system adopted for a line in course of construction during 1904, the termini of which will be Baltimore and Washington, D. C. It will be operated by electricity, and the current will be derived from an overhead trolley which will assist also in holding the cars upright as they travel over a single rail, laid upon the ground as in ordinary railroad building. The line will be an experimental one to the extent that upon its success will depend the building of similar lines in all directions from Baltimore and Washington.

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Railways, High Speed. By «high speed railways» is meant those on which it is attempted to obtain speeds considerably in excess of those customary with the best equipped express trains. There has been a gradual increase in the speed of all railway trains with the development of the art. The roadbed and the track have been improved and made heavier, cars have been made stronger, the running gear has undergone marked changes, and the locomotive has been made heavier and more powerful, all of which have contributed to the greater speeds now common. But the changes have been gradual. There has been no sudden increase which in the limited meaning of this expression could properly be called high speed operation. Except in a few notable instances, attempts to secure high speeds have been merely isolated experiments in which a train has been run at an exceptionally high velocity, which, however, was maintained for a short time only.

Such tests have not been productive of any change in operative methods, though they have shown that a train would run safely on a good track at speeds considerably above those customary, and they indicated that the power required was less than had been supposed. In such tests the locomotive is limited by the steaming capacity of its boiler, which in our present designs is not great enough to supply the heavy demands made by the engine. This is the difficulty standing in the way of any great decrease in the speed of steam-drawn trains. It is known that the track and the cars will stand the strain and the engine can safely make the necessary number of revolutions per minute, but for this it requires more steam than the boiler can supply and it is difficult, if not impossible, to increase the boiler capacity to any extent.

This limiting factor is not present in an electrically operated train and the possibility of thus obtaining a greatly increased speed was recognized as soon as the success of the electrically operated street car had been demonstrated. In this case the supply of power is limited only by the power of the station, which can be increased indefinitely, and by the current which can be collected from the working conductors. The speed then depends upon the

1. The Pennsylvania Special.
2. The Twentieth Century Limited Speeding a Mile in 35 Seconds.

size of the motors and the track construction. A number of attempts have been made to see what could be done in this direction in some peculiar track construction being resorted to. It will, however, be sufficient to take up the first and the last instances.

About 1866, a company known as the Electro-Automatic Railway Company, was organized in Baltimore, Md., to develop a high speed automatic parcel express between large cities. An experimental track, circular in shape and about two miles in circumference, was constructed at Laurel, Md. The gauge was 28 inches, the weight of rails 16 pounds to the yard. Wooden guard rails were laid alongside the running rails and a vertical framework on both sides of the track supported by means of a wooden stringer a light third rail, head down, over the centre of the track. This served as the working conductor and it was thought would hold the car on the track. In this latter duty it failed, and the whole track construction was found to be far too light for the purpose for which it was intended. Current was returned through the track rails.

The car was a steel box, 16 feet long, 24 inches high and 30 inches wide, with pyramidal ends. It was mounted on three axles with 28 inch wheels, and on each axle was placed a 20 horse-power direct current motor. Later the central motor was taken off. The car weighed complete, three tons, and the motors were designed for a speed of 3,000 revolutions per minute, which would give a car speed of 250 miles per hour.

The road was tested in the fall of 1889. Speeds up to 115 miles per hour were obtained, but it was found impossible to keep the car on the track when moving at high velocities. On the last test it left the track when moving with a speed of 115 miles per hour, wrecking the car and 1,000 feet of the track. With a track at all suited to the work, the car could have maintained a speed of 120 miles per hour indefinitely. The engineer in charge of the test advised building a heavier track and car, but as the necessary money was not available the work was stopped.

The tests, while not giving much data, served to show that the train resistance formulæ then in use were not applicable to high speeds. For fuller information, consult report of 'High Speed Electric Railway Work,' by O. T. Crosby; Transactions of the American Institute of Electrical Engineers (Vol. VIII., 1890–1).

The latest tests of importance are those begun in 1901 on a 14 mile stretch of track between Marienfeld and Zossen, near Berlin, Germany. The road is nearly straight, with slight grades. The track was first laid with 70 pound rails on iron ties, but this proved unable to stand high speeds and was relaid with 92 pound rails on iron chairs, spiked to wooden ties. The old rails were laid as guard rails on the inside, but from later tests this precaution seems to have been unnecessary. The track is ballasted with broken basalt. Over this track a car mounted on two three-wheel trucks, each truck equipped with two 250 horse-power three-phase motors, was run at various times at increasing speeds until on 6 Oct. 1903, a speed of 126 miles per hour was reached. Later in the month higher speeds, in one case a little over 130 miles per hour, were reached, but unofficially. The car carried a number of observers and ran quite smoothly. The curve was taken at a somewhat reduced speed. During the fastest runs about 1,000 horse-power was developed by the four motors.

The car weighed about 100 tons. The motors are supplied with current at from 1,150 to 1,850 volts from transformers on the car, which reduce the line voltage from 14,000. Current was collected from three line wires by means of two sets of bow contacts. The complete data and computed results of these tests have not yet been made public (March 1904), but the success of the experiments has induced a number of German steam railroads to plan for higher speeds on their existing tracks. In the United States, the New York Central Railway, acting with the General Electric Company, is planning to carry out a similar investigation, and will, if possible, exceed the German speeds. The German tests demonstrated the safety of trains at 125 miles per hour on a straight well-laid track and showed that the requisite power could be collected without difficulty. It is evident that such speeds can be allowed only on a road having no grade crossings, and a change in signaling methods will be necessary to enable the engineer to bring his train under control within the block. The probable financial success of such high speed lines may properly be questioned. No doubt they would carry much, if not all, of the long distance traffic. For short distances they are not feasible. They will be expensive to operate and will probably not greatly increase the present traffic. However, the tendency is toward higher speeds and eventually the public demand will bring it about.

Wm. Hand Browne, Jr.,
'Electrical Review,' New York.

Railways, Inclined and Mountain. Inclined and mountain railways are similar in their object — the ascension of heights by railway carriages; but the term, "inclined railway," is commonly applied to a line of rails and cars supported on or against the steep side of an elevation, and used to carry passengers and also live stock and vehicles to and from the top of the elevation. Such are the inclined railways on the south side of the Monongahela River at Pittsburg, and on the New Jersey side of the Hudson River, opposite New York. The inclined railway is one of the devices for facilitating travel in and about cities, and bears about the same relation to a mountain railway that a ferry-boat does to a coastwise steamship. It can be propelled by cable, with steam as the motive power, or by electricity. The use of the inclined railway is not as general as might be expected, considering the extensive tracts of land in the vicinity of New York and other cities which the inclined railway would make readily accessible.

The mountain railway is of American origin, but other countries quickly adopted a means so obviously useful in making mountain travel comparatively safe and comfortable for traveler and tourist. The first mountain railway was opened at Mauch Chunk, Pa., in May 1827. It was first used to draw coals from the mines to the Lehigh River, the cars descending by gravity, and being returned by mules. A stationary engine on the summit has taken the place of the mules, and the train is now used only by tourists. The Mount Washington Railway, in the White Mountains, N. H., opened in 1869, is very steep, and has a grade in places of one foot in three. The track is of three rails, bolted to a heavy timber trestle, the cogwheel which draws the train running up the centre rail. The seats are suspended so as to swing horizontally. The Otis Elevating Railway, in the Catskills, has an incline 7,000 feet in length with a rise of 1,000 feet.

In the Western United States, also, are some celebrated mountain railways, including the road from Manitou to the summit of Pike's Peak, Colo., eight miles long, and ascending 14,146 feet. The aerial railway over the Chilkoot Pass to Lake Linderman, Alaska, completed early in 1898, shortened the time from tidewater to the headwaters of the Yukon River from a month to a day, and greatly reduced the hardships of a journey to the mines.

Switzerland presents some fine examples of mountain railways. The electric railway to the summit of the Jungfrau (13,670 feet), constructed in 1903 and 1904, is a triumph of modern engineering. The greater part of the way is underground, and galleries are cut at each station to allow passengers to obtain views of the magnificent scenery. The average gradient is 17 per cent, the maximum being 25 per cent. The gauge of the track is 39 inches, the weight of the rails is 42 pounds per yard, and these are bonded and cross-bonded. The sleepers are of steel of the usual continental type, and the rails are fixed by means of bolts and clamps. The journey to the top occupies about one hour and forty minutes, which enables the passengers to accustom themselves to the altered conditions of the atmosphere. At the terminus station the passenger may ascend to the summit of the great mountain, with its dazzling shroud of eternal snow, either by a lift 242 feet high, or by a winding staircase on the outside.

Another interesting mountain railway is that which circles Mount Etna in Sicily. Twenty-two miles of cutting had to be made through lava as hard as granite, and the line, which is only 70 miles long, required four years to complete. It passes through a flourishing region and also scenes of former havoc by volcanic eruptions, and is much appreciated by tourists.

Railways, Laws Affecting. See CARRIER, COMMON.

Railways, Suspended. See SUSPENSION RAILWAYS.

Railways, Underground. See SUBWAYS.

Raimond, rā'mŏnd, **C. E.** See PARKES, ELIZABETH ROBINS.

Raimondi, rī-mōn'dē, **Marco Antonio** (MARKANTON), Italian copper-plate engraver: b. Bologna about 1488. He acquired the goldsmith's art in France and was especially successful in niello, but finally gave all his attention to engraving on copper. In 1505 he went to Venice and attracted attention by his copy on metal plate of Dürer's 'Life of the Virgin.' He was later attracted to Rome, where Raphael soon selected him as the engraver of his pictures. After Raphael's death Giulio Romano commissioned him to make plates from 20 of his best paintings, but having reproduced some licentious designs of that artist, Pope Clement VII. ordered the plates to be destroyed by the public executioner and Raimondi was cast into prison. He was released through the intercession of the sculptor Bandinelli, and to show his gratitude Raimondi made a copy in line engraving of Bandinelli's 'Martyrdom of Saint Lawrence.' Losing his property in the sack of Rome (1527) he returned to Bologna where all traces of him are lost. The value of his engravings after Raphael lies in the fact that they were executed under that artist's eye, and were many of them copies, not of completed pictures, but of rough draughts and tentative designs, which but for these copper-plate reproductions would have been lost to the world. Being thus brought in intimate relation with the painter's methods, he became the best interpreter of Raphael in black and white, and no engraver has so completely entered into the spirit and power of expression which breathe in the canvases of the greatest Italian painter. His best engravings after Raphael include 'Adam and Eve'; 'God Commands Noah to Build the Ark'; 'The Massacre of the Innocents'; 'Mary with the Dead Christ'; 'The Judgment of Paris'; 'The Three Doctors of the Church.' Consult: Delaborde, 'Marc-Antoine Raimondi' (1887).

Raimund de Sabunde, rī'moond dā sāboon'dā, scholastic philosopher: b. Barcelona. In 1436 he appears at Toulouse as a teacher of medicine, philosophy, and theology, and he labored especially to reconcile the apparent contradictions between nature or reason and the Bible; an undertaking which led him into the realm of mysticism. In his 'Liber Creaturarum seu Thologiæ Naturalis' he applied this principle so as practically to reconstruct the whole system of Church doctrine. He and his system have been discussed by Matzke (1846); Huttler (1851); and F. Nitzsch in the 'Zeitschrift für historische Theologie' (1859).

Rain, water dropping through the atmosphere. A mass of air in the atmosphere always contains some aqueous vapor, and if this air is cooled below a certain temperature, called the dew-point (which depends on the amount of vapor present), the vapor will condense into drops of water. This cooling may be due to radiation of heat to colder regions, or to mixture with colder masses of air. When air rises in the atmosphere to colder regions, or comes in contact with a cold part of the earth, or passes from equatorial to polar parts of the earth, its moisture tends to condense into rain. In considering the probable rainfall of a place we are concerned with its latitude, its elevation above the sea, its proximity to the sea, the laws affecting its seasonable variations, the prevailing winds, and the configuration of the surrounding surface. Low latitudes have in general a heavy rainfall, because of the greater evaporation in tropical regions, and the consequent formation of rain when the clouds due to evaporation get colder in the higher regions of the atmosphere. Hence also winds blowing from the equator are generally moist, and winds blowing to the equator are generally dry. The presence of forests tends to increase the rainfall (see METEOROLOGY), and the rain further encourages vegetation. The influence of the seasons on rainfall is pretty regular in the tropics. Over the ocean the skies are clear where the trade-winds are blowing steadily, and heavy rain falls by day in the zone of calms; on land there is a regular alternation of dry and wet seasons. Toward the equator, where there is a considerable interval between the two passages of the sun across the zenith, there are two rainy seasons. In monsoon regions, however, the alternation of dry and wet seasons depends on the winds. Beyond the tropics we have variable winds and variable rainfall. The following table gives recent figures for the mean annual rainfall of a number of stations in various parts of the world:

	Inches
Greytown (Nicaragua)	260
Freetown (Sierra Leone)	125.8
Rangoon	99
Bahia	95.1
Batum	93
Rockingham Bay (Queensland)	90
Colombo	88
Astoria (Oregon)	86.3
Saigon	82.96
Nagasaki	77.6
Bergen (Norway)	73
Batavia	71.4
Bombay	70.3
Vera Cruz	67.9
Calcutta	65.6
Tokyo	60.4
Manila	55.2
New Orleans	55.17
St. John's (Newfoundland)	52.9
Brisbane	52.36
Sydney	49.86
Madras	48.69
Havana	46.5
Quebec	46.07
Glasgow	45.4
Halifax (Nova Scotia)	45.34
New York	44.76
Auckland	43.62
St. Louis	40.69
Durban	39.48
Montreal	39.28
Bogota	39
Pietermaritzburg	38
Chicago	37.57
Kingston (Jamaica)	35.79
Toronto	34.4
Buenos Ayres	34.1
Belfast	34
Perth (Australia)	32
St. John (New Brunswick)	31.75
Ottawa	31.4
Rome	30.6
Berlin	29.98
Liverpool	29.01
Dublin	28.4
Edinburgh	28.32
Algiers	26.72
Charlottetown	26.71
Melbourne	26.6
Smyrna	25.63
Cape Town	25.01
London	25
San Francisco	24.08
Vienna	23.42
Nairn	23.3
Bathurst	23
Mexico	22.9
Bloemfontein	21.29
Moscow	21.1
Upsala	21.1
Lahore	21
Adelaide	20.25
Winnipeg	20.12
Marseilles	20.08
Paris	19.68
St. Petersburg	18.8
Tobolsk	18.6
Kimberley	18.26
Irkutsk	16.5
Denver	14.9
Santiago (Chile)	14.1
Odessa	14
Yakutsk	13.7
Valparaiso	13.5
Vladivostok	13.2
North Cape	10
Regina	8.38
Okhotsk	7.5
Yuma (Arizona)	2.9
Cairo	1.34
Walfisch Bay	.3

It has been proven that rain has a most cleansing effect on the atmosphere, a five days' rainfall in London, England, having carried off not less than 3,738 tons of solid impurities, including 267 tons of sulphate of ammonia, and 2,000 tons of soot and suspended matters.

Rain-birds, various birds so called because of their observed or supposed connection with rains or the foretelling of wet weather. The cuckoos seem to be most widely credited with foreknowledge of storms, as they are in the habit of calling most noisily at such times. Thus the yellow-billed cuckoo (see CUCKOO) is called «rain-crow» in the Southern and Western States. Further Southwest, and in Mexico and Central America, the name is given to the anis (q.v.); while in the West Indies two or three other cuckoos are so termed. These are familiar species of the genera *Saurothera*, *Hyetornis*, and *Piaya*, the last named extending over most of the Andean region. The rainbird of India is a quail (*Coturnix Coromandelica*), which recalls one of the names, «wet-my-lip» of the American eastern quail; and that of the Malay region is one of the broadbills (*Cymborynchus*). In England the green woodpecker is called «rain-bird»; and in the Orkney Islands one, the loons, especially the red-necked, is known as «rain-goose.» The prophetic power of the birds is exaggerated in popular estimation; but probably they do somewhat perceive a coming change of weather, especially of increased moisture, and those, like the above mentioned, which are naturally noisy, do then call more loudly and frequently than usual.

Rain-gauge, or **Pluviometer**, an instrument which measures the depth of the rainfall at any place. In its commonest form it consists of a cylindric vessel closed at the top by a funnel-shaped lid, through a hole in the centre of which the rain falls. A narrow glass tube, rising outside the vessel from near the bottom, shows by the height of the water in it the height of the water in the vessel itself. A very simple rain-gauge consists of a copper funnel, the area of whose opening is exactly 10 square inches. This funnel allows the rain to pass into a bottle, and the quantity of rain caught is ascertained by multiplying the weight in ounces by 0.173, which gives the depth in inches. As a rain-gauge is nearer the ground it is found to indicate a greater rainfall. This is partly due to the cold rain-drops getting larger in falling through the very moist air near the ground, and partly to the greater occurrence of eddies about the gauge at greater heights. Hence, when the rainfall at two places is to be compared, the gauges ought to be similarly situated. A rain-gauge must be placed in as open a position as possible, out of the way of houses, trees, and similar objects.

Rain-making. The subject of rain-making, or bringing rain from the clouds in a season of drought, has in all ages been of the greatest interest to humanity, as lack of rain has caused many famines and the loss of many millions of lives. Attempts have been made to bring rain by appeals to Divine Providence in prayer in Christian countries, while the ignorant heathen practise various forms of fetishism, and even offer up human sacrifices with the same object. Owing to the large extent of arid lands in the United States the question of bringing about rain by scientific processes has engaged attention for many years past. It was noted that forest fires have often been followed by rain, and in 1834 James P. Espy, of Pennsylvania, proposed the building of enormous fires in the regions where rain was desired, to bring about the needed showers. This was regarded as impracticable both in America and in Australia where it was also suggested. That great battles, and sometimes lesser ones, attended by cannonading, were occasionally followed by heavy rainfalls is a historic fact, and this gave origin to the belief that explosions similar to those of artillery might bring about rain in a season of drought. This belief did not apparently take into account the circumstance that important battles are usually fought in temperate regions, with normal rainfall, and where a disturbance of the atmosphere might easily bring a downpour from the skies. It is also averred by the opponents of this theory that the number of battles followed by rain has been comparatively small. In 1891, however, Congress made an appropriation for a series of experiments in Texas, which were conducted by

Gen. Dyrenforth for the Department of Agriculture. There has been much controversy as to the effect of these experiments which were conducted on the theory of provoking rainfall by concussion caused by explosions, giant powder being the explosive used. Gen. Dyrenforth claimed that the experiments were entirely successful, that the drops sometimes commenced to fall within 12 seconds after the initial explosion, and that «the concussions from explosions exert a marked and practical effect upon the atmospheric conditions, in producing or occasioning rainfall, probably by disturbing the upper currents.» On the other hand, Prof. A. H. Hazen, basing his views on the newspaper reports of the experiments, argued that there was no evidence whatever that any rainfall had been produced by the explosions, while W. K. Curtis, M.D., who was with the Dyrenforth party, substantially confirmed Prof. Hazen's view, and declared that rain fell before the experiments had begun. The weight of evidence was generally accepted by the public as supporting the views of Hazen and Curtis, and while the theory that rain frequently follows aerial explosions has not been abandoned, no serious efforts have been made to follow up the experiments of Gen. Dyrenforth. See METEOROLOGY.

Rain-tree, a leguminous tree (*Pithecolobium saman*) of tropical America, now largely planted in India for the shade it furnishes, and because it flourishes in barren salt-impregnated soils, as well as for its sweet pulpy twisted pods, which are greedily eaten by cattle. Another species (*P. dulce*) with edible pods is a native of Mexico, but has been introduced into the Philippine Islands and also into India.

Rainbow. The rainbow is the best known of all optical meteorological phenomena, consisting of a colored arch formed opposite the sun on falling raindrops, and visible whenever the necessary conditions of a passing shower on one side and a clear and not too high sun on the other occur. Two bows are frequently seen, each exhibiting the full spectrum of colors from red to violet; but in the inner or primary bow the red is the outer edge and violet the inner, while in the outer or secondary bow the order is reversed, the red being inside and the violet on the exterior. The colors are always arranged in a definite order, that of the solar spectrum,— namely, red, orange, yellow, green, blue, indigo, and violet, but shade imperceptibly into each other. The cause of this breaking up of the sunlight into its constituent colors is explained in most physical and meteorological text-books, but may be briefly summarized as follows:

For the primary bow (Fig. 1), let PQR represent the section of a raindrop, and SP a ray of light falling on it. The ray enters the drop at P, meets the surface again at R, is reflected to Q, where it leaves the drop in the direction of QE. The ray is refracted or bent on entering the drop at P and again on emerging at Q — the amount of this refraction depending on the acuteness of the angle at which the ray meets the surface. Now it may be shown that there is a particular point P, such that any ray from S striking the surface below P emerges again above Q, and any ray above P also emerges above Q — the former owing to the more acute angle of the reflection, and the latter to the greater refraction on entering and leaving the drop. The course of two such rays is shown by the dotted lines in Fig. 1. Q is thus a turning-point in the emerging rays, and near it a very large number of rays pass out, and an observer at E sees a bright image of S in the direction EQ. This statement applies to any one color of sunlight; but, as the refrangibility increases from red to violet, the latter is bent more at P and Q, and the line EQ lies at a flatter angle. The observer, therefore, sees the violet rays reflected on drops at a less altitude than those that reflect the red, the other colors being intermediate. The raindrop being spherical, this reflection takes place in all directions, the fixed condition being the radius of the bow, that is the angle between the line from the observer to the bow and that passing from the sun to the observer, or, in other words, the observer's shadow. For red light this angle is 42° 39', and for violet 40° 13'. If the sun were a luminous point each color would be sharply defined, but as the disk of the sun subtends an angle of about 30' each color is broadened to this amount, and they overlap.

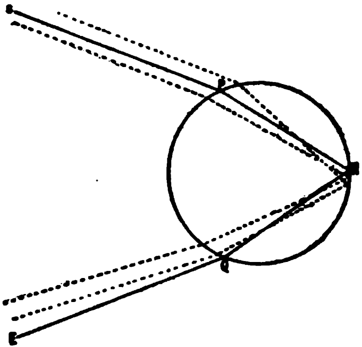

FIG. 1.

Exactly similar reasoning explains the secondary bow (Fig. 2). The light that forms it has been twice reflected, at R and at R'; the point Q lies above P, and rays entering either above or below P all emerge below Q. A glance at the diagram will show that the greater bending of the more refrangible rays makes the line EQ more nearly vertical, and therefore the violet rays form the outer edge and the red the inner of the secondary bow. The radius of the red is 50° 5', and of the violet 54° 0'. The space between the bows gets no reflected light, but that inside the primary and outside the secondary is faintly illuminated by rays such as are indicated by the dotted lines in Fig. 1 and their equivalents in Fig. 2, which are not shown. These rays «interfere» with each other, and cause alternations of color which appear as spurious bows inside the primary and outside the secondary. They can only be seen with strong sunlight and small drops of rain.

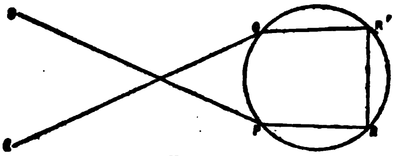

FIG. 2.

The radius of the primary bow being roughly

40°, it is evident that it cannot be seen when the sun is at a greater elevation than this, as the highest part of the bow would lie below the horizon. See LIGHT.

Rainbow Falls. See CHELAN, LAKE.

Rainbow Trout, a fresh-water fish (*Salmo irrideus*) indigenous to the mountain streams and rivers of the Pacific coast of the United States, but widely introduced into eastern waters. From the eastern brook-trout (*Salvelinus fontinalis*) it may be easily distinguished by its colors and the presence of teeth on the vomer bone; from the related salmon trouts, with some difficulty, by its small mouth, and the number of scales, about 135 in typical examples, along the lateral line. The rainbow trout is exceedingly variable and many distinct forms, which are considered by ichthyologists to be modifications of this species but which have received distinct vernacular names, are found occupying particular streams or watersheds. The complex relations of the various species of trout and salmon to their environment is little understood. From fish-culturists the McCloud River trout (*S. irrideus shasta*) has received much attention since 1880. This variety is particularly well adapted for stocking streams and ponds in which the brook-trout no longer thrives owing to the clearing of the forests and the resulting higher temperature and increased muddiness of the water. To supply the great and constant demand for young fish for stocking purposes the Federal Fish Commission maintains several large hatcheries and many States others. Carefully selected breeding fish are kept in specially constructed ponds designed with reference to cleanliness, good circulation, and ease of handling the fish. Spawning occurs during the winter. The ripe females are stripped in the usual way and the eggs mixed with the milt in a pan either with or without water. After a few minutes water is added and they are gently agitated and repeatedly washed to remove the surplus sperm, and, after standing about an hour, are transferred to the hatching trays, which are constructed of galvanized wire. These trays are arranged in troughs with running water in such a way that the young fry fall into the latter as they hatch. As the fry grow and begin to feed they are distributed to other troughs and finally to rearing ponds constructed in a manner to insure cleanliness and an abundance of flowing water. The young are fed on ground liver and are transplanted when several months old. They grow rapidly, but in the East never attain the large size which they do in their native streams. They feed on insect larvæ, etc., and may be fed artificially on chopped beef or liver mixed with corn meal. For angling purposes the rainbow is inferior to the brook-trout, but is a fair substitute.

Raines, John, politician: b. Canandaigua, N. Y., 6 May 1840; d. 22 Feb. 1909. He was graduated from the Albany Law School in 1861, and admitted to the bar. He served in the Civil War as captain from 1861 to 1863; then began his law practice. He was a Republican member of the New York Assembly in 1881–2, and again in 1885; of Congress in 1889–93; and of the State Senate in 1886–9, and 1895–09. In 1903–4 he was president *pro tem.* of the Senate and chairman of the committee on rules. He is best known as the author of the Raines Liquor Law (q.v.), and he also framed the State election law.

Raines' Law, so called from State Senator John Raines, who introduced the measure, a law passed in 1896 by the legislature of New York, and since amended in several particulars, but always retaining the essential features of State control of the liquor traffic, and high license for cities, the present full license under the amendments of 1903 being $1,200 in the old city of New York, and $800 in the borough of Brooklyn. The law permits hotels to sell to guests on Sunday, and this has led to the establishment of numerous places known as «Raines' Law Hotels,» which comply with the strict letter of hotel regulations, but do what is chiefly a liquor saloon business. The law has been very profitable in its operation both for city and State, the city receiving two thirds and the State one third of the net income from licenses. In the year ending 30 April 1903 the net receipts were $7,991,865.39 in New York city, as against $1,736,918.43, the last year of the old excise law in all the municipalities which now constitute the city.

Rainier, rā'nēr, **Mount,** a peak in the State of Washington, belonging to the Cascade Range, 14,520 feet above sea-level and about 10,000 feet above the surrounding land. It is near Puget Sound, east of Tacoma, and it is sometimes called Tacoma. It is of volcanic origin, cone shaped; its crater still sends out volcanic gases, but it is classed with the extinct volcanoes. The eroded slopes indicate there has been no eruption for hundreds of years. The base and the lower slope are covered with forests, but the summit is snow-capped. There are a number of glaciers on the summit. The first ascent of the mountain was made in 1870. In 1897 it was ascended and quite thoroughly explored by a large party. See ROCKY MOUNTAINS.

Rains, George Washington, American military officer: b. Craven County, N. C., 1817; d. Newburgh, N. Y., 21 March 1898. He was graduated from West Point in 1842, served in the engineering corps, was transferred to the artillery, and in 1844–6 was assistant professor of chemistry, mineralogy, and geology at West Point. He served on the staffs of Gens. Scott and Pillar in the Mexican War, and received brevet rank of major, was active in the Seminole War, and in 1856 he resigned from the army and engaged in business. At the outbreak of the Civil War he entered the Confederate service, was commissioned a colonel and placed in charge of the building and equipment of a powder mill at Augusta, Ga., where he remained until the end of the war, receiving promotion to the rank of brigadier-general. In 1867 he became professor of chemistry and pharmacy in the University of Georgia, and was dean of the faculty there till 1884. He was interested in mechanics, and secured several patents on his inventions for improvements for steam-engines. He wrote: ‘Steam Portable Engines’ (1860); ‘Rudimentary Course of Analytical and Applied Chemistry’ (1872); ‘History of the Confederate Powder Works’ (1882); etc.

Rains'ford, William Stephen, American Episcopal clergyman: b. Dublin, Ireland, 30 Oct. 1850. He was graduated from Saint John's College, Cambridge, in 1872, took orders in the

English Church, and in 1873–6 was curate at Saint Giles', Norwich, England. In 1876 he came to the United States and engaged in evangelistic services in New York. He was assistant rector at Saint James Cathedral, Toronto, 1876–83, and in the last named year became rector of Saint George's Church, New York but resigned in 1906. Under his management the work of the parish was greatly extended and many societies and missions were established in connection with it. He is widely known as an earnest, fearless, and eloquent preacher. He has published: 'Sermons Preached in Saint George's'; 'Reasonableness of Faith' (1902); 'A Preacher's Story of His Work' (1904), etc.

Rainy, Robert, Scottish Presbyterian clergyman: b. Glasgow, Scotland, 1 Jan. 1826; d. 22 Dec. 1906. He was educated at the University of Glasgow, held various important pastorates in the Free Church, was professor of church history at New College, Edinburgh, in 1862–1900, and from 1874 was principal there. He published: 'Life of Principal Cunningham' (1871); 'The Bible and Criticism' (1878); 'The Ancient Catholic Church' (1901); etc.

Rainy Lake, Canada, between Lakes Superior and Winnipeg, forms part of the boundary between Canada and the United States. It is about 40 miles long by 15 miles broad, receives the waters of numerous small lakes from the east and northeast, and empties itself by Rainy River, about 90 miles long, into the Lake of the Woods.

Raised Beaches. See BEACHES, RAISED.

Raisin, the commercial name for the dried or cured grape. In Europe the raisin product comes largely from Italy and France, and in the United States almost wholly from California. See RAISIN INDUSTRY, THE.

Raisin Industry, The American, is confined almost wholly to California. The raisin crop comes from the great San Joaquin Valley and from several counties in southern California. The headquarters of the industry are about Fresno. The California raisin grape culture began to be of commercial importance in 1874, when the output was 9,000 boxes, or 180,000 pounds of raisins. The industry advanced "by leaps and bounds" up to 1894, when the crop amounted to 103,000,000 pounds — figures which have never since been exceeded, or even equaled. The markets "broke" under this great output, and the crop sold for less than 2 cents per pound. As a result there was a sharp decline both in the acreage and in the output of raisins during the next four or five years. However, the growers protected themselves and their market by forming, in 1898, a Raisin Growers' Association, which controlled about 90 per cent of the yield. This association still continues to handle the bulk of the raisin crop, and has been quite successful in distributing to the best advantage the large output in the different markets. Last year (1902) the California raisin crop amounted to 100,000,000 pounds. The standard box of raisins weighs 20 pounds, and contains four layers of five pounds each. The raisins are packed and graded into layers, and one, two and three crown loose. The processes of curing, seeding, and packing raisins have been improved from time to time, and to-day machines do much of the work formerly done by hand. The first great device was a patent seeder, and the latest one is a raisin-packing machine, by which the packages, or cartons, are filled, weighed and sealed.

The leading varieties of grapes used for raisins are: Muscatel, Gordo Blanco, Muscat of Alexandria, and Malaga; for seedless raisins, Sultana and Thompson's Seedless. Grapes are ripe by the middle of August, and the season often lasts into November. The average time of drying and curing a tray of raisins is about three weeks, all depending on the weather. The earliest picked grapes dry in ten days, and the later ones often take four weeks and even more. The method of drying is very simple. The bunches are cut from the vines and placed on shallow trays two feet wide, three feet long, and one inch high, on which the grapes are allowed to sun-dry, being turned from time to time by simply placing an empty tray top side down on the full one, then turning both over, and taking off the top tray. After the raisins are dried they are stored away in the sweat boxes until they are packed and prepared for shipment. Some of the larger growers, in order not to run so much risk in drying on account of rain, and also to enable them to handle the crop fast enough, have curing houses, where the curing is finished after having been partially done outside. The seeding, grading, packing, and shipping have become separate branches. In the season of 1901–2 some 60 plants, most of them located in the Fresno district, were engaged in this part of the work. These establishments furnished employment for 5,000 employees, and the aggregate wages paid out to them each month during the season was nearly $250,000.

The exports of California raisins first became of sufficient importance to be separately stated in the official reports of the treasury department in the fiscal year ending June, 1892. Raisins were first sent in small quantities to all parts of the world, but the trade has grown quite rapidly. In 1898 the exports amounted to 3,109,639 pounds, and in 1902 to 2,323,274 pounds.

The following figures serve to show how the foreign raisin trade has fallen off, and how California raisins have monopolized the markets of this country:

RAISINS PRODUCED AND IMPORTED.

Year	Raisins produced Pounds	Raisins imported Pounds
1885	9,400,000	53,702,220
1890	38,000,000	36,914,330
1895	91,360,000	15,921,278
1898	80,631,000	6,592,833
1902	100,000,000	6,563,302
1910	....	5,042,693

LEE J. VANCE,
Editor of the 'American Wine Press.'

Raisin River, Battle of. See MONROE, MICH.

Raja, rä'jä, or **Rajah,** a title of hereditary princes of the Hindus. Before the subjugation of the country by the Moguls the various countries of Hindustan were governed by rajas, who belonged to the Kshatriyas or military caste. They were sometimes independent rulers and again feudatory, and the highest title, "Maharaja," was given to those who controlled other sovereigns. The title is now usually merely honorary and is not confined to any caste, while those retaining some degree of actual authority under the British are now designated "Maharaja." Consult: Foy, 'Die königliche Gewalt nach den altindischen Rechtsbüchern' (1895); Jolly, 'Recht und Sitte' (1896).

Rajamandry, rä-jä-măn'drē, or **Rajamahendri,** India, a town of the Godavari district, Madras, on the east bank of the Godavari (here three miles wide), 30 miles from the sea. Among buildings and institutions are the court-house and judge's residence, churches, mission of the American Evangelical Lutheran Church, provincial college, several schools, museum, dispensary, public garden, and large prison. Pop. 28,500.

Rajmahal, räj-mạ-häl', India, on an eminence overlooking the Ganges, 170 miles northwest of Calcutta, for many years ranked first among the towns of the Bengal and Bahar provinces. It is now noteworthy only for its palatial ruins, and as a station in an important transit trade.

Rajon, rä-zhôṅ, **Paul Adolphe,** French etcher: b. Dijon 1842; d. Auvers 8 June 1888. He was trained at the Ecole des Beaux Arts at Paris, and in 1865 produced his first etching after Meissonnier 'Rembrandt at Work.' His many subsequent works won for him the leading position among French etchers, and on visiting England in 1872 he found his reputation had preceded him and was commissioned to make an etched copy of John Stuart Mill's portrait by George Frederick Watts, and of Tennyson's portrait by the same painter. He was eminently successful in these and other portrait etchings, but his most ambitious and brilliant work was 'The Emperor Claudis' after Alma Tadema.

Rajputana, räj-poo-tä'nạ, India, a western political division, extending from the Jamna and Chambal rivers, west to Sind and Bhawalpur, and comprising the greater part of the Indian Desert. It consists of a number of native states controlled by the British assistant political agencies of Mewar, Jaipur, Marwar, Haraoti, Eastern States Agency, Alwar, and Sirohi; together with the British enclave of Ajmir-Merwara. The total area of the native states is 127,541 English square miles; or including the British district of Ajmir-Merwara 130,252 square miles. The maharajas and rajas are supreme in their own states, and settle disputes among themselves in courts of their own. A great portion of the surface of Rajputana is desert, and part of it wholly destitute of inhabitants, water, and vegetation. The whole of the soil is remarkably saline, containing many salt springs and salt lakes, and much of the well-water is brackish. The rainfall is scanty, and the region frequently suffers from famine. In many places it is covered with the cactus and other prickly shrubs; except in the Aravalli Hills which traverse the region from southwest to northeast, the territory is almost destitute of trees. Where practicable, pastoral and agricultural pursuits occupy the people. Conditions have slightly improved since British enterprise has opened up the country by a transversal line of railroad, with diverging branches, connecting with the rest of the Peninsular railway system. The chief town is Jaipur, other urban centres are Bikanir, Jodhpur, Bhartpur, Udaipur, and Tonk. While the chiefs are of Rajput origin, the Rajput element is in the minority among the population, which consists chiefly of Hindus, with Mohammedans, Animists, and Jains. Pop. (1891) 11,990,504; (1901) 9,723,301, showing a decrease in the decade of 2,267,203, mainly due to the famine of 1899–1900.

Rajputs, räj-poots', a people of India, giving their name to Rajputana (q.v.), and said to be a branch of the Kshatriyas, one of the four great castes into which the Hindus were originally divided. They are essentially a military people, and many of their institutions bear a strong resemblance to the feudal customs which prevailed in Europe in the Middle Ages. They are celebrated for their chivalrous spirit in marked contrast to the usual effeminacy and duplicity of many of the Oriental nations. The practice of female infanticide, however, at one time was prevalent among them, until suppressed by British influence; the profuse use of opium has likewise in many cases produced a lamentable deterioration in their physical and moral state. Notwithstanding these drawbacks the Rajput character contains much that is noble and generous. The Rajputs became first connected with the British government under the governorship of the Marquis of Wellesley, in the beginning of the 19th century. Besides Rajputana, the Rajputs are numerous in Sind and Guzerat.

Rájsháhi, räj-shä'hē, India, a division or commissionership of Bengal, extending from the Ganges to Sikkim and Bhutan. Area, 17,351 square miles; pop. (1901) 8,489,788. The district of Rájsháhi, forming part of the division, has an area of 2,330 square miles; a population of about 1,400,000. The capital of the division and district is Rámpur Beauleah.

Rákóczy, rä'kōt-sē, a Transylvanian princely family now extinct in the male line. They were for some time rulers of the principality of Siebenbürgen, or Transylvania, and by a rigorous maintenance of the civil and religious rights of the inhabitants made their influence over their subjects such as to render them formidable to the power of the royal house of Austria. The first prince of the name was SIGISMUND RÁKÓCZY, who obtained the government in 1606, but abdicated in favor of Gabriel Bathori in 1608. His son, GEORGE RÁKÓCZY (b. 1591; d. 24 Oct. 1648), assumed the sovereignty in 1629 and regained for his subjects many lost privileges. He was succeeded by his son, GEORGE II. (b. 1615; d. 8 July 1676), who attempted an invasion of Poland, was defeated and forced to abdicate, but regained his authority. He died after having been again forced to resign. His son, Francis I., never reigned, but was implicated in various political complications and the last of the family to hold sovereign power was his grandson, Francis II. (q.v.).

Rákóczy, Francis II., Transylvanian prince: b. 27 March 1676; d. Rodosto, Turkey, 8 April 1735. His attempt to free his country from Austrian rule resulted in his being sentenced to death for high treason, but he contrived to escape, rallied the Hungarians to his support and was proclaimed protector. The alliance of certain of the Hungarian states with Austria afterward caused his defeat and he resigned his estates and went to Turkey. He wrote: ‘Mémoirs sur les Revolutions de Hongrie’ (1738).

Rakoczy March, the name of a Hungarian military air by an unknown composer of the 17th century, said to have been the favorite march of Francis Rakoczy II. of Transylvania. See NATIONAL HYMNS.

Rale, räl (spelled also incorrectly, RASLE, RASLES, and RALLE), **Sebastien,** French Jesuit missionary in North America: b. Franche-Comté 1657; d. Norridgewock, Maine, 12 Aug. 1724. In 1675 he became a Jesuit novice at Dôle, in 1677-84 was an instructor at Carpentras and Nimes, and in 1689 was sent to the American missions. For two years he was among the Abenakis near the mouth of the Chaudière in the mission of Saint Francis. Then he passed two years among the Illinois, and finally was placed in charge of the Abenakis of Kennebec. He was believed by the English to be the cause of their difficulties with the Abenakis, and was accused of instigating attacks on the settlements. This is inferred by pro-English historians from a letter to Rale from Vaudreuil, governor at Quebec, expressing satisfaction at Rale's success in uniting the savages against the English, and agreeing to furnish military assistance, should it be required. This communication, dated 25 Sept. 1721, was among papers obtained by the expedition sent out from Boston under Colonel Westbrook to seize Rale in 1721, and is now preserved in the archives of Massachusetts. Among these papers, also, was Rale's dictionary of Abenaki, now in the Harvard library and printed in 1833, in the memoirs of the American Academy of Arts and Sciences, See DUMMER'S WAR.

Raleigh, SIR Walter, English military and naval commander, and author: b. Hayes Barton, a farmstead in the parish of East Budleigh, Devonshire, about 1552; beheaded, London, 29 Oct. 1618. He was the son of Walter Raleigh by his third wife, Katharine, daughter of Sir Philip Champernowne of Modbury, and widow of Otho Gilbert of Compton. Raleigh was educated at Oriel College, Oxford; served with the Huguenot army in France in 1569; remained there for five years or more; and, with his half-brother, Sir Humphrey Gilbert, engaged in voyages of «discovery»—and piracy—against the Spaniards in the West Indies. In 1579, he established himself at court in the friendship of men of influence—Leicester, Oxford, Sidney, Walsingham; he served with distinction in Ireland (1580-81); and then, returning to court in December of the latter year, he won, and for some years retained, the high favor of Elizabeth. Through her successive grants of monopolies and estates, he became one of the wealthiest of her courtiers. In 1584 he was knighted; in 1585 he was appointed warden of the stannaries (*i. e.* of the mines of Devon and Cornwall), lord lieutenant of the latter county, and vice-admiral of both; and in 1585-6 he was M.P. for Devon. He was also captain of the queen's guard.

From this period while Raleigh was the favorite of Elizabeth dates his chief connection with the exploration and settlement of North America. In 1584, '85, '86, '87, and '89, he sent expeditions to Virginia; but as the Queen forbade his personal participation, his efforts to colonize were unsuccessful. Raleigh's services against the Spanish Armada, 1588, were not conspicuous. He assisted in organizing the land forces; but there is no proof that he took any part in the sea-fighting. In 1591 and 1592, he was prominent in the preparation of squadrons for service against Spain; but was recalled from the later expedition because of the Queen's anger at Raleigh's intrigue with one of her maids of honor, Elizabeth Throgmorton. He was soon set at liberty, and his marriage to Elizabeth Throgmorton followed. Not until 1597, however, did Raleigh regain the Queen's favor.

Meanwhile he was free to explore America in person. His objective point was Manoa, a city supposedly situated in South America and possessed of untold wealth. In 1595, with a fleet of five vessels, he captured the town of San Josef, Trinidad, and explored the Orinoco for 400 miles. He did not find Manoa; but his brilliant service in the English attack upon Cadiz (June 1596), and as commander at the taking of Fayal (1597), completed his restoration to favor. In 1597 he was made M.P. for Dorset; in 1601, for Cornwall. In 1600 he was appointed governor of Jersey.

The death of Elizabeth, however, occasioned a change in Raleigh's fortunes. Raleigh's enemies had made James believe that Raleigh was opposed to his accession. James immediately deprived him of all offices, and on 17 July 1603, committed him to the tower. On November 17, he was tried for treason. According to modern rules the evidence was insufficient; but Raleigh was declared guilty and was sentenced to be executed on 11 December.

On 10 December, however, he was reprieved and committed to the tower. Here for 13 years he lived in tolerable comfort with his wife, son, and personal servants. He devoted himself to study and to scientific experiments, and, at the request of Prince Henry, began his chief literary work, the ‘History of the World.’ At length, in March 1616, on his promise to guide an expedition to a gold mine in America, Raleigh was released. The Spanish ambassador, fearing an invasion of Spanish possessions or an attack on the Mexican plate-fleet, protested. The king, however, warning Raleigh that either act would be punishable by death, allowed him to proceed. Raleigh ignored the warning, captured San Tomás, and, failing to reach the mine, was kept from attacking the plate-fleet only by the refusal of his followers. On Raleigh's return to England, Gondomar, the Spanish ambassador, demanded his immediate execution. Raleigh's admissions and perjuries left the king's commissioners no choice. On 28 October, the Justices of the King's Bench ordered Raleigh's execution under the suspended sentence of 1603. He was executed in the Old Palace Yard, 29 Oct. 1618.

Of Raleigh's poetry, so highly praised by his

SIR WALTER RALEIGH.

contemporaries, but little was published during his life, and much is probably lost. Many poems once attributed to him are now attributed to others. The poems certainly his have been collected by Dr. Hannah, 1885. Of Raleigh's prose works, the most important is his 'History of the World' (1614).

Bibliography.—The chief lives of Raleigh are those of William Oldys (1736); Thomas Birch (1751); Arthur Cayley (1805); Patrick Fraser-Tytler (1833); Edward Edwards (1868); J. A. St. John (1868); and Mr. William Stebbing (1891). That by Mr. Stebbing is the best. There is also a popular sketch by Mr. Edmund Gosse (1886). Consult also Mr. S. R. Gardiner's 'History of England,' and the publications of the Hist. MSS. Comm., and, concerning Raleigh's literary work, the introduction to Dr. Hannah's edition of his 'Poems' (1885), the bibliographies of Dr. Brushfield, and his 'Sir Walter Raleigh and His History of the World' (1887).

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Raleigh, Walter, English author and educator. He was educated at University College, London, and King's College, Cambridge, and was for many years professor of modern literature at University College, Liverpool. Since 1900 he has occupied the chair of English language and literature at Glasgow University. He has published: 'The English Novel' (1894); 'Robert Louis Stevenson' (1895); 'Style' (1897); 'Milton' (1900); 'Wordsworth' (1903); etc.

Raleigh, N. C., city, capital of the State, county-seat of Wake County; in lat. 35° 47′ N., lon. 78° 48′ W.; on the Southern and the Seaboard Air Line R.R.'s; about 28 miles southeast of Durham, 148 miles northwest of Wilmington, and 60 miles northeast of Pinehurst.

Topography.— Raleigh occupies an elevation of over 300 feet. It is just northeast of the geographical centre of the State, in the upper valley of the Neuse River, which flows southeast to Pamlico Sound. The city, platted around a beautiful park of 10 acres, which is called Union Square, is divided into four sections by four broad streets which extend from this centre. The magnificent oak trees in Union Square give Raleigh the popular name of "The City of Oaks."

Manufacturing.— In 1900 the manufacturing interests of Raleigh represented an invested capital of $1,611,000, with products valued at $2,204,000. Cotton and tobacco products are the leading articles of commerce. The largest manufacturing establishments are flour mills, phosphate works, foundries, machine shops, car shops, wood-working factories, ice factories, cotton mills, and cottonseed-oil mills. Other manufactures are underclothing, hosiery, cigars, carriages, and agricultural implements.

Buildings and Cemeteries.— The State Capitol, a substantial granite structure, stands in Union Square; nearby are the Supreme Court building, the State Library, State Geological Museum, Raney Library, Governor's mansion, U. S. Government post-office and court-house. Other prominent public buildings are the county court-house, State insane asylum, State penitentiary, State institutions for the blind, one for white and one for colored, State Institute for the Deaf and Dumb, Old Ladies' Home, and Rex Hospital. There are here National and Confederate cemeteries. The National Cemetery contains 1,207 graves, 572 of which are unknown dead.

Education.— The educational institutions are the Peace Institute (Presbyterian), Saint Mary's (P. E.), and the Baptist Female University, for young women; Raleigh Male Academy, for boys. The State College of Agricultural and Mechanic Arts, opened in 1889, has 15 buildings, and accommodations for 600 students. Other schools are King's Business College; the Shaw University (Baptist) and Saint Augustine's School (P. E.) are for boys and girls. Several State educational institutions have been mentioned. There are graded and normal schools for white and colored pupils. A large summer school for white teachers is held here each year. Not far distant from the city are the State University and the Wake Forest College (Baptist). The Supreme Court Library contains 14,000 volumes, the State Library 35,000 volumes, and the Olivia Raney public library 8,000 volumes. All the religious denominations have handsome churches for both races. There are two orphanages, one under the auspices of the Methodist Church, the other in charge of the Roman Catholic Church. There are three daily and ten weekly newspapers.

Banks and Finances.— There are two national banks, one state bank, two savings banks, and one trust company. The five banks and the trust company have a combined capital of $555,000 and deposits amounting to $2,541,610. The assessed property valuation, in 1903, was $6,000,000. There are excellent fire and police departments, and all municipal improvements are provided for by a regular tax.

Government.— The city is governed under a charter of 1899 which provides for a mayor and common council elected every two years. The administrative officials are chosen by the mayor and council, except the tax collector and city clerk who are elected by the people.

History.— The site of the present city was selected in 1792 by the legislature, for the location of the State capital. In the same year the city was founded and named in honor of Walter Raleigh (q.v.). In 1794 the legislature held its first session in Raleigh. The city was incorporated in 1795, and in 1803 was re-incorporated. The city was occupied by General Sherman part of 1865. Pop. (1880) 9,265; (1890) 12,678; (1900) 13,643; (1910) 19,218. Consult Battle, 'The Early History of Raleigh.'

GEORGE ALLEN,
Sec. Chamber of Commerce, Raleigh, N. C.

Râles, sounds heard in the respiratory passages, due to certain modifications in the normal structure of the bronchi or alveoli, or both. Sounds that originate in the pleural cavity are distinguished as friction sounds. Râles are new sounds, not common to healthy lungs, and are created either in the bronchi, bronchioles, air-vesicles, or pathological cavities. They are due to a number of causes, the most frequent of which are (1) the passage of air through narrowed bronchi, such narrowing being the result of inflammation of the mucous membrane or of muscular spasm, and (2) the passage of air through or by a certain amount of fluid, either mucus, pus, blood-serum, or combinations of these. Râles of the first type are dry; those of the second are called wet. The dry râles are usually musical, and on placing the ear to the chest, where they are present, one hears either high-pitched whistling sounds, sibilant râles, or low-pitched, blowing, or sonorous râles, depending on the source of the sound, whether the finer or larger bronchi. Both types may commingle. Such râles are common in asthma, in the chronic bronchitis of emphysema, and in the early stages of a bronchitis, before the exudation of mucus has begun. The moist râles are usually of two kinds: (1) very fine, or subcrepitant râles, resembling in sound the rubbing of a lock of hair between the fingers, and (2) larger mucous râles. The former are common in various types of disease in which the air-vesicles are involved, broncho-pneumonia, lobar pneumonia, tuberculous pneumonia, etc. They are due to congestion and the pouring out of blood-serum into the area. The moist mucous râles are present in bronchitis. They occur in the larger bronchi, or in cavities, and resemble the bubbling and gurgling sounds of water in a pipe. It requires the trained ear of the physician to distinguish between the different varieties, and much experience to be able to prejudge the significance of the râles after they are heard.

Ralph, James, American author: b. Philadelphia, Pa., about 1698; d. Chiswick, Surrey, England, 24 Jan. 1762. He was a clerk to a Philadelphia conveyancer, and in 1724 went to England with Benjamin Franklin, who praises him as «ingenious» and «extremely eloquent.» As an actor, editor, and newspaper writer he was not successful. He then became a teacher in Berkshire, and was welcomed as an adherent of the Prince of Wales' party, which he supported by pamphlet, poem, and newspaper contribution. Afterwards bought into silence, he received a pension on the accession of George III. Pope ridicules «a thing of his, entitled ‘Night,’ a poem,» in the lines of the ‘Dunciad,’

> "Silence ye wolves! while Ralph to Cynthia howls,
> And makes night hideous — Answer him, ye Owls!"

Franklin pathetically complains that he «did his best to dissuade Ralph from attempting to become a poet»; but apparently Pope was more effective. Ralph's ‘History of England during the Reigns of King William, Queen Anne, and George I.’ (1744) is valuable for the information it contains.

Ralph, Julian, American author: b. New York 27 May 1853; d. there 20 Jan. 1903. At 13 he began newspaper work as typesetter and later engaged as reporter at Red Bank, N. J. From here he removed to Webster, Mass., to edit *The Times* of that place, and thence to New York, where he came into prominence in reporting the Beecher trial in 1875. He at once engaged with the New York *Sun* and held a position on its staff for 20 years. He was in the East during the Chinese-Japanese war in 1894 reporting that struggle and traveling in many parts of Asia. Returning to London he joined the foreign staff of the New York *Journal* and reported the Turkish-Greek war, Queen Victoria's Diamond Jubilee in 1897, and the crowning of the Czar of Russia. The outbreak of the Boer war found him again a field correspondent, attached to the commands of Lords Roberts and Methuen. He returned to America in 1902 and continued his work of special correspondent up to the time of his death. He had a wide knowledge of affairs and a picturesque and vivid style. Some of his books are: ‘On Canada's Frontier’; ‘Our Great West’; ‘Chicago and the World's Fair’; ‘People We Pass’; ‘Alone in China’; ‘An Angel in the Web’; ‘At Pretoria’; ‘War's Brighter Side.’

Ralph Iron. See Schreiner, Olive.

Ralph Roister Doister, a play by Nicholas Udall. It was the first English comedy, although not printed until 1556, and probably written about 1540. At this time its author was head-master of Eton, and the comedy was written for the schoolboys, whose custom it was to act a Latin play at the Christmas season. An English play was an innovation, but ‘Ralph Roister Doister’ was very successful. It follows Terence and Plautus, Ralph, «a swaggering simpleton, a feeble, conceited fop of the days of Henry VIII.,» having his prototype in the ‘Miles Gloriosus.’ It is in riming couplets, interspersed with songs. In very recent years it has been produced at Tufts College, Medford, Mass.

Ralston, râl'stôn, **William Ralston Shedden,** English Russian scholar: b. London 4 April 1828; d. there 6 Aug. 1889. He was the son of W. P. Ralston Shedden and educated at Cambridge. During the period of his college years his father entered upon a litigation to obtain possession of some Ayrshire property and in this effort dissipated his whole fortune. The name of Shedden becoming somewhat notorious in connection with the suit, the son adopted the additional surname of Ralston; and obtained a post at the British Museum in 1853. He gave his attention to the study of Russian, a language then little known. He published ‘Kriloff and His Fables’ (1868), a translation of Turguénieff's ‘Liza’ (1869); ‘Songs of the Russian People’ (1872), and ‘Russian Folk Tales’ (1873). He made several journeys to Russia and became the life-long friend of Turguénieff, and was also made a corresponding member of the Imperial Academy of Sciences of Saint Petersburg. He projected an exhaustive history of Russia, but did not publish it. In 1874, however, he published his Oxford Taylorian lectures, ‘Early Russian History.’

Ram, Thomas, English bishop: b. Windsor 1564; d. Dublin 24 Nov. 1634. He was educated at Eton and Cambridge, and in 1599 accompanied Essex to Ireland, and in the following year was made dean of Cork. On 2 May 1605 he was consecrated bishop of the united sees of Ferns and Leighlin. Ram was a careful bishop, constantly resident, and did what he could to maintain schools, but the recusant clergy excommunicated all who used them. He was one of the twelve bishops who, 26 Nov. 1626, signed a protest against tolerating popery.

Ram, Battering. See Battering-ram.

Ram, Hydraulic. See Hydraulics.

Râma, rä'ma, in Hindu mythology, the name common to a personage appearing as three incarnations of Vishnu (q.v.), all great warriors of surpassing beauty. These three forms are distinguished as Bala Râmâ or Balaram, Parasurama or Parasram, and Râmâ Chandra or Dasrat Râmâ. Râmâ first appeared in the sixth incarnation, and his deeds are celebrated in a poem called the 'Râmâyana,' the best great epic poem of ancient India. In this poem all three of the heroes are celebrated, but the last-named, or Râmâ Chandra, has his life and deeds detailed at greater length than the others. The story tells how Sita, his wife, was carried away to Ceylon by the king of demons, one Ravana, and how Râmâ rescued his wife, bridging the water between Ceylon and India by the aid of an army of monkeys. He slew the demons and became a great hero. The Râmâyana is often likened to the 'Iliad,' to which it bears great resemblance.

Ramadan, rä-mä-dän' or răm-ạ-dăn', the ninth month in the Mohammedan calendar, has 30 days. Since the Mohammedan year is a lunar one, Ramadan comes at all the seasons, being eleven days earlier each year. In about 33 years the month has made a complete cycle of the year. Ramadan is important chiefly because it is supposed to be the month in which Mohammed received his divine revelation and is therefore made a month of solemn observance among the faithful. During the 30 days the true believer abstains, between dawn and sunset, from all eating, drinking, smoking; bathing and all other delights of the body are likewise forbidden. The more devout of the Mohammedans remain behind closed blinds during the day and devote themselves to prayer and to reading the Koran, and particularly Sura, in the second book of which are found the references to the fast of Ramadan. There are special prayers, 20 in number, which during this month are added to the usual evening prayers, repeated at dusk by the true believer.. Ramadan is also the month in which the Turkish Government usually takes occasion to institute reforms, or to promise to institute them, apparently to curtail the national expenses and lighten the tax burden, and generally to undertake those measures that tend to popularize the government with its subjects.

The rigid fast enjoined by the Koran is not required of those who are unable, because of physical reasons, to withstand it. Thus mothers with young babies, and those expecting to become such, infirm old people, people weakened by illness, and others in like circumstances, are excused in whole or in part. In some instances, as is the case with soldiers on active duty, the remission is conditional upon a future fast of similar length and severity.

The fast of Ramadan terminates each day with nightfall, and as the Mohammedan keeps the letter rather than the spirit of the law of the Koran, the nights of this month are filled with feasting, the more joyous because of the abstinence during the day. These repasts often become wild revels, or even flagrant debauches, which last until daylight, when the glutted participants once more partake themselves to fasting and prayer. Following the fast of Ramadan for three days there is celebrated the feast of the *Lesser Beiram*, during which all labor ceases and the Mohammedans give themselves to all sorts of table enjoyments.

Râmayana, rä-mä'yạ-nạ. See SANSKRIT LANGUAGE AND LITERATURE.

Rambaud, räṅ-bō, **Alfred Nicholas,** French historian and litterateur: b. Besançon 2 July 1842. He was educated at the Ecole Normale; in 1871 became professor of history at Caen and in 1875 was transferred to the same post at Nancy. In 1879 he became secretary to the Ministry of Public Instruction, and in 1881 was nominated to a position in the Normal School at Caen and shortly afterward made professor of modern history at Paris. From 1896 to 1898 he was minister of public instruction in the Méline Cabinet. His chief works are 'La Russie Epique' (1876); 'Histoire de la Russie' (1878); 'Histoire de la Civilisation Française' (1887); 'Histoire de la Civilisation Contemporaine en France' (1888); in collaboration with M. Lavisse, 'Histoire Generale de la France du IVe Siècle à nos Jours' (1892).

Ramberg, räm'bĕrg, **Arthur,** BARON, German painter: b. Vienna 4 Sept. 1819; d. Munich 5 Feb. 1875. He studied art at Hanover and early made a tour in Italy, Hungary, and Styria. In 1840 he attended the university at Prague, while at the same time uniting the pursuit of art with his other studies. In 1842 he became a pupil at the Art Academy of Dresden under J. Hübner, and among other early pictures produced his 'Wedding of Dwarfs' after Goethe; and 'The Emperor Henry I. on His Hungarian Campaign.' In 1850 he went to Munich and executed a series of genres illustrating the works of Schiller. In 1860 he was appointed professor to the Art School in Weimar, and six years later took a similar position in the academy of Munich. His subsequent productions include 'The Court of Frederick II. in Palermo'; and, among his genres, most notable are his 'Hermann und Dorothea' after Goethe; and 'Luise,' after the poem of J. H. Voss, which latter was much admired for its brilliancy in design and execution. He also frescoed the walls of Luther's chamber at Wartburg; and for the Grand Duchess of Saxe-Weimar illustrated the tale of the 'King of the Frogs.'

Ramberg, räm'bĕrg, **Johann Heinrich,** German artist: b. Hanover 1763; d. there 6 July 1840. He first showed his talent by drawings of scenes in the Harz Mountains. These became known to George III., king of England, his sovereign, as Elector of Hanover, who induced him to go to London, where he provided for him. He remained there nine years, and perfected himself under Reynolds. Murphy, Bartolozzi, and other engravers of the first rank in England, engraved drawings of his. In 1788 the king sent him to Italy, whence he returned to Hanover, where he was appointed painter to the court. Few painters and designers have produced so many works as he; but this rapidity prevented the full development of his talent. He distinguished himself particularly in humorous drawings; as in his illustrations to 'Reineke Fuchs' and 'Eulenspiegel.' The drawings in the magnificent edition of Wieland's works are all by him; some he etched himself.

Rambler, The, a semi-weekly periodical after the model of Addison's 'Spectator,' published in London by Dr. Samuel Johnson 1750–52, and, like its prototype, of much influence upon English life in the 18th century.

Ramboo'tan, the fruit of the tree *Nephelium lappaceum*, of the order *Sapindaceæ*, much prized in the Malayan Archipelago. It is about the size of a pigeon's egg, of a red color, rich and of a pleasant acid taste. The fruits litchi

through or by a certain amount of [illegible]
mucus, pus, blood-serum, or [illegible]
these. Râles of the first [illegible]
the second are called [illegible]
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[illegible] Catherine [illegible] worthy [illegible] Ram[illegible] to the [illegible] became a [illegible] was [illegible] French court [illegible] manners and [illegible] and refinement [illegible] became the rendezvous [illegible] the critics, poets, [illegible] thither were Mal[illegible] Chapelain, Scarron, Saint-[illegible] Rochefoucauld, Mme. de Sévigné. [illegible] Louis XIII. were quite indifferent [illegible] in default of royal patronage the [illegible] role of arbiter in matters [illegible] assumed the role [illegible] Imitators perverted the original character of the group into pedantry and affectation [illegible] occasioned the historic satires of the great Molière in 'Les Précieuses Ridicules' and 'Les Femmes Savantes.' The Hôtel did much to add to the precision and finish of the language and the establishment of good taste; and it was unfortunate that through the playwright its name took on the nature of a derisive epithet. Consult: Röderer, 'Mémoire pour servir à l'Histoire de la Société Polie en France pendant le Dix-septième Siècle' (1834); Brunetière, 'Nouvelles Etudes Critiques' (2d ed. 1886); Vincent, 'The Hôtel de Rambouillet' (1900).

Rambouillet, a breed of sheep (q.v.).

Rameau, Jean Phillippe, zhŏṅ fē-lēp rä-mō, French musical composer and theorist: b. Dijon 25 Sept. 1683; d. Paris 12 Sept. 1764. Having early acquired some skill in music he joined a company of performers, by whom when he was 18 a composition of his was represented at Avignon. He studied sacred music under Marchand at Paris; was appointed organist in Clermont cathedral, and in 1722 made his reputation as a musical theorist by publishing 'Traité de l'Harmonie.' Four years after appeared his 'Nouveau Système de Musique Théorique,' which was followed by his 'Génération Harmonique.' His greatest claim to musical reputation is based upon his dramatic compositions, of which 'Hippolyte et Aricie' appeared in 1732 and was followed by 22 works of grand opera, of which the most notable is 'Castor and Pollux' (1737). In 1750 he published his 'Dissertation sur le Principe de l'Harmonie,' in which he reduces harmony to one single principle — the fundamental bass, on which he proves all the rest to depend. This work procured him an invitation from the court to superintend the opera at Paris. Louis XV. granted him a patent of nobility, and the order of Saint Michael, and in 1876 a statue was raised to him in his native city. Consult: Pougin, 'Rameau, Essai sur sa Vie et ses Œuvres' (1876).

Ramée, rä-mā', Louise de la. See Ouida.

Ramée, Pierre, pē-ār rä-mā (Latinized, Petrus Ramus), French humanist and mathematician: b. Cuth, near Soissons, 1515; d. Paris 26 Aug. 1572. He went to Paris about 1523 when he was but eight years old, and became lackey to a rich student in the College of [illegible] but devoted to self-improvement all the [illegible] could spare. After attending a course of [illegible]ophy he was admitted to the degree of [illegible], on which occasion he questioned the infallibility of Aristotle. His 'Institutionum Dialecticarum Libri III' (1543), and 'Animadversionum in Dialecticam Aristotelis Libri XX' raised a storm against him in the university; their publication was prohibited, and extant copies ordered to be burned before the Royal College of Cambrai. Having obtained the patronage of the Cardinal De Lorraine, the prohibition of lecturing imposed in 1543 was withdrawn in 1547, and in 1551 he was appointed professor of rhetoric and philosophy in the College Royal at Paris. His spirit of free inquiry ultimately led him to become a Protestant, and he was obliged to flee from Paris, but he unfortunately returned in 1571 and was killed in the massacre of Saint Bartholomew's. His works, relating to grammar, logic, mathematics, etc., are numerous.

His doctrines were widely diffused. France, England, and particularly Scotland, were full of Ramists. His logic was introduced into the University of Glasgow and in the German universities. Consult: Waddington, 'Ramus, sa Vie, see Ecrits et ses Opinions' (1855); Desmaze, 'Ramus' (1864); Lobstein, 'P. Remus als Theolog' (1878); Voigt, 'Ueber den Ramismus der Universität Leipzig' (1888); Owen, 'Skeptics of the French Revolution' (1893).

Ramenghi, rä mĕng'gē, Bartolomeo. See Bagnacavallo.

Rameses, răm'ĕ-sēz, or Ramses (in Egyptian "the Child of the Sun"), the name of several Egyptian kings, especially of the 19th and 20th dynasties, of which the most notable are:

Rameses II. (Gr. Sesostris), son of Sethos. He was the third king of the 19th dynasty, and reigned 1300–1280 B.C. He made a campaign against Syria and advanced victoriously as far as Berytus (Beirut), on the Phœnician coast of the Mediterranean. He next extended Egyptian dominion over Ethiopia, and a part of Arabia and began the cutting of a canal between the Mediterranean and Red seas. But the great event of his reign was his war with the Khita, supposed to be the Hittites. He defeated a confederation, among whom the Khita were the chief, in a great battle near the Kadeshon (Orontes) in Syria, and subsequently took Jerusalem and other places. He fortified the east of Egypt by erecting a great wall from Pelusium to Heliopolis and Tanis. In his reign Thebes rose to great magnificence. Here he erected the splendid temple known as the Rameseum, with a sitting statue of himself more than 60 feet high. He is the king who oppressed the Hebrews, and the father of Menephthat, under whom the exodus took place. He had 111 sons and 59 daughters, and we have more records and statues of him than of any other Pharaoh. His mummy was discovered near Thebes in 1881 and in 1886 placed in the Egyptian Museum at Cairo.

Rameses III., the Rhampsinitus of Herodotus, belonged to the 20th dynasty, and was also a king of note, some of whose achievements seem to have been ascribed to Sesostris. He reigned 1180–1150 B.C., during which period he had to withstand many invasions of the surrounding nations, but was uniformly successful in war, and active in great undertakings in time of peace. At Medinet-Abu he built a magnificent temple in memory of his warlike achievements in Nubia and Syria. The mummy of Rameses III. was found in 1886. Nine other kings of the name of Rameses are mentioned as having belonged to the 20th dynasty (1150–1050).

Rameses, a city of Egypt, in the district of the same name, supposed to be the same as Raamses, one of the treasure-cities built for Pharaoh by the children of Israel during their bondage in Egypt. It was from this point that the Israelites set out in their exodus from Egypt; and its geographical position is therefore of great interest as determining their route toward the Red Sea. The district or "land" of Rameses has been identified by some with Goshen, or a part of Goshen. As for the city, some have supposed it to be in the neighborhood of On or Heliopolis; others somewhere near Old Cairo, on the opposite side of the Nile from ancient Memphis; Dr. Robinson placed it in the valley of Wady Toumilât, toward the east end of that valley, in the line of the fresh-water canal to Ismailia; and Dr. Lepsius thought he had found its site at Tell-el-Maskhuta, in that region. This site, however, has been identified by Naville with Pithom. It is argued in favor of the conjecture which places it in the neighborhood of Memphis, that Rameses must have been near the capital or residence of Pharaoh at the time of the exodus, and as this was Memphis, Rameses must therefore have been near this city. But though Memphis was the ancient capital, it does not follow that the Egyptian king invariably resided there. Tanis or Zoan was also a royal residence, and Brugsch identifies Rameses with it, an identification which suits the biblical narrative quite well. Upon the name of the city is based the theory which identifies Rameses II. with the Pharaoh of the oppression.

Ramesseum, răm-ĕs-sē'ŭm, a temple of ancient Egypt, on the western bank of the Nile, situated opposite Thebes, and near the modern village of El-Kurneh. Its ruins constitute one of the most interesting group of ancient Egyptian remains, owing to the rich mural sculptures of great historical value which are there preserved. The principal features of the temple were two great courts about 140 feet long by 180 feet wide, entered through a propylon 225 feet wide. The front court contains the fragments of a gigantic statue of Rameses II. carved from a single block of granite and estimated to have weighed, when entire, more than 850 tons. The statue was 60 feet high and the monarch was represented as seated on his throne. The columns in both courts are among the most beautiful specimens of Egyptian architecture. On the wall of the second court is a great series of sculptures depicting a battle between Rameses II. and the Hittites, in which the king is shown as victoriously pursuing the enemy's forces. Opening on the second court is a beautiful hall of pillars, the walls of which are adorned with battle scenes and religious subjects. A smaller chamber adjacent to the hall of pillars is notable for its astronomical ceiling. The temple was described by Diodorus Siculus under the name of the Tomb of Osymandyas. It is sometimes called the Memnonium.

Rameswaram, rä-mĕs'wa-räm, a low sandy island between the southern extremity of India and Ceylon, and between the Gulf of Manaar and Palk Strait, about 14 miles long and 5 wide. It is one of the islands that form the chain known as Adam's Bridge, and contains a famous Hindu temple of Dravidian architecture, which attracts many pilgrims from all parts of India. The port of the island is Pambam; it also contains a small town called Rameswaram. There is a passage for ships of moderate size between this island and the continent. Pop. 17,854.

Ram'iè, Rhea, or **China Grass,** *Bœhmeria tenacissima* and *B. nivea.* Shrubs, five to eight feet high, producing in the bark of their stalks or stems a bast fibre. Technically ramiè and rhea are derived from *tenacissima* and China grass from *nivea.* This distinction has never been regarded, however, in the economic literature of the subject, the term ramiè being commonly used to designate all *bœhmeria* fibre, China grass being either a synonym or the trade name of the Chinese fibre as imported. In the statements which follow, therefore, ramiè and China grass may be considered as synonymous terms, referring to the fibres of both species, as they are practically identical from the standpoint of commercial utility, and as regards culture, preparation and manufacture.

The fibre is strong and durable, is least affected by moisture of all fibres, and takes first rank as a textile substance. It is adapted to the widest range of uses of any known textile. It has been made into stuff goods for men's wear, ladies' dress goods, upholstery, curtains, laces, and embroideries. The pile of velvets and plushes, stockings, underclothing and knit goods, table damask, napkins, handkerchiefs, shirtings, sheetings, sail duck, carpets, cordage, fishing nets, and yarns and thread of all descriptions, and it makes a superior bank-note paper. It is also used to adulterate silk, and for imitation silk goods. The plant has been the subject of experiment in nearly every country in the world, and probably millions of dollars have been spent or wasted, in attempts to exploit the industry, or in the construction of machines to extract the fibre. Yet the fact remains that the commercial fibre is only produced in China and by rudest hand methods, Japan coming the nearest to establishing a commercial industry for the production of export fibre. Ramiè is neither grown nor to any extent manufactured in the United States, though its culture was experimented with for years, and inventors and textile manufacturers have struggled with the machine problem, and with the after preparation and the spinning of the fibre. As far as this country is concerned, the fact that the Chinese fibre can be laid down in San Francisco for about 4 cents a pound condenses the entire ramiè situation into a nutshell. Cultivation in this country would not pay at such prices, and there is not a machine in existence that could produce enough marketable fibre in a day to pay for the cost of running the machines when American wages are considered.

Ramiè manufactures have been on the market for years, derived from European sources, and made from raw fibre produced in China. And many manufactures made in whole, or part, from ramiè are sold as something else, because the fibre is unknown to the public, or because it is used as an adulterant, as in silk fabrics. See China, Cordage, Cordage Industries, Fibre Hemp, Rope.

Consult 'Report on Rhea Fibers' (Watson, 1875); Bulletin Royal Kew Gardens; Dictionary Economic Products of India; Reports (1, 2, and 7) Office of Fibre Investigations, Department of Agriculture; also the French publications of Favier, De Landtsheer, Michatte, Roux, Ringlemann, and the ramiè literature published by the Ministry of Agriculture of France.

CHAS. RICHARDS DODGE.

Ramillies, rā-mē-yē, a village of Belgium, in the province of Brabant, 13 miles north of Namur and 28 miles southeast of Brussels. On 23 May 1706 the Duke of Marlborough gained here a signal victory over the French under Marshal Villeroi and the Elector of Bavaria. The numbers were about 60,000 on each side; the loss of the allies was about 4,000 men, that of the French 15,000. The consequence of this battle was the immediate evacuation by the French of the chief strongholds in the Netherlands. See SPANISH SUCCESSION, WAR OF THE.

Ramirez, rā-mē'rěth, **Ignacio,** Mexican poet and philosopher: b. San Miguel el Grande 23 June 1818; d. Mexico 15 June 1879. He was descended from a family of pure Aztec blood, received a good education and early devoted his attention to literature. He founded 'Don Simplicio' in 1846 and was author under the pseudonym "The Necromancer" of many philosophical articles and satirical poems. His writings have never been collected, but his 'Manual of Rudimentary Knowledge' was published in 1884.

Ramman, răm'man, or **Rimmon,** a deity worshipped by the Babylonians and sometimes called also Hadad. He was the god of the all-pervading atmosphere, especially of the winds. In this respect he may be likened to the Meeruts, or storm gods of northern India, for his name is derived from a Babylonian word meaning "loud sounding" or "bellowing." In the Bible "the House of Rimmon" is spoken of as his temple at Damascus (2 Kings v. 18). He is symbolized by the bull; is the god of storms and floods and of the charge of battle and is represented armed with thunderbolt and battle-axe. Consult: Baethgen, 'Beiträge zur semitischen Religionsgeschichte' (1902); Jastrow, 'Religion of Babylonia and Assyria' (1898).

Rammohun Roy, răm-mō-hŭn' roi, Hindu religious reformer: b. Burdwan district, province of Bengal, India, 1772; d. Stapleton Park, near Bristol, England, 27 Sept. 1833. He was a Brahman of strict education, but early renounced the polytheism of Brahminic theology. For five years he was dewan, or principal native officer in the collection of the revenues, in one of the districts of East India company's services. He afterward studied Latin, Greek, and Hebrew. A careful study of the sacred writings of the Hindus had convinced him that the prevailing religious notions of the Hindus were grounded upon a gross perversion of their religion, the original records of which appeared to him to inculcate a system of pure theism. He now became anxious to reform the creed and practice of his countrymen, and determined to devote his talents and his fortune to this undertaking. A work of his in Persian on 'The Idolatry of all Religions' aroused much protest. In 1814 he went to live in Calcutta, where as early as 1818 he had united a number of intelligent Hindus in a species of monotheistic worship. He translated the Vedanta, a compendium of the doctrines contained in the Vedas or ancient sacred books of the Hindus, from the Sanskrit into the Bengali and Hindustani languages, and distributed the translation gratuitously. This he afterward published in English, for the purpose of proving to his European friends "that the superstitious practices which deform the Hindu religion have nothing to do with the pure spirit of its dictates." From the perusal of the New Testament he found (he says) the doctrines of Christ more conducive to moral principles, and better adapted for the use of rational beings, than any other which had come to his knowledge. In 1820 he accordingly published the 'Precepts of Jesus the Guide to Peace and Happiness,' consisting chiefly of a selection of moral precepts from the Evangelists, and Unitarian in its character. On 23 Jan. 1830 he founded at Calcutta the Brahmiya Somaj, from which was derived the Brahamo Somaj (q.v.).

Rammohun Roy, in his doctrinal views, was a Unitarian, holding, however, the pre-existence and superangelic dignity of Christ, and considering the doctrine of the Trinity as a species of polytheism. He believed possible a combination of Brahminism and Christianity. His views were at first much misunderstood in England, and it appears that even Bishop Heber regarded him as an atheist. In 1830 he went to England in the character of ambassador from the king of Delhi (who gave him the title of Rajah). Consult: Carpenter, 'A Review of the Labors, Opinions, and Character of Rajah Rammohun Roy' (1833); Fox, 'Discourse on Occasion of the death of Rajah Rammohun Roy' (1833); Max Müller, 'Biographical Essays' (1883).

Ramo'na, a novel by Mrs. Helen Hunt Jackson, published in 1884. It is a picturesque, sympathetic, and faithful picture of Spanish and Indian life in California. Though the story is a passionate appeal for justice to the Indian it is in form one of the most delicate and beautiful examples of romantic literary art that English affords.

Ram'pion, a biennial herb (*Campanula rapunculus*) of the order *Campanulaceæ*. It grows about 30 inches tall, has a parsnip-like root, obovate leaves, lilac flowers in a spike or raceme, and very small seeds. It is a native of Asia, Europe and northern Africa, where it is cultivated for its roots and leaves, the former of which are used like radishes, the latter like spinach. The plants do best in light, rich loam, partially shaded and well supplied with moisture but not wet. Since early spring sown plants are likely to run to seed, other sowings should be made in early summer. The plant is less popular in America than abroad.

Rampolla, răm-pōl'lā, **Mariano,** MARQUIS DEL TINDARO, Roman prelate: b. at Polizzi, Sicily, 17 Aug. 1843. Born of an aristocratic family he was educated at Rome and took priest's orders at 23. Several years later he entered diplomacy and was made secretary to the Papal nunciature at Madrid. During the absence of the Nuncio Simonei in 1876 he acted so brilliant a part during the Carlist war as to secure his appointment as secretary of the Congregation of the Propaganda. In 1885, being then Papal Nuncio at Madrid, he proposed Pope Leo XIII. as arbitrator in the dispute between Spain and Germany regarding the Caroline Islands. In 1887 he was created cardinal and made papal secretary of state which post he held until the appointment of the new Pope Pius X. in 1903. The foreign policy of the Vatican was influenced by him and consisted of a conciliatory attitude toward France together with an opposition to the Triple Alliance, with the ultimate end in view of re-establishing the temporal power of the pope. Upon the death of Leo XIII. Cardinal Rampolla was one of the most prominent candidates to the succession.

Rámpur, räm-poor′, India, (1) capital of a state of the same name, on the left bank of the Kosila River, 18 miles east of Moradabad. It is the residence of the nawab, who represents the Rohilla chieftain of Rohilkhand. A lofty mosque is a specimen of oriental magnificence. The place is famous for its shawls, damask, sword-blades and jewelry. Pop. (1901) 77,862. (2) The state under the superintendence of the government of the United Provinces has an area of 899 square miles.

Ramsay, răm′zĭ, **Allan**, Scottish poet: b. Leadhills, Lanarkshire, 15 Oct. 1686; d. Edinburgh 7 Jan. 1758. The death of his father in early life forced him to seek a means of livelihood in the Scottish capital. There he became bound as an apprentice to a wig-maker, which occupation he continued after his apprenticeship had ceased. The exact period when he commenced bookselling is unknown, but he is said to have been the first who established a circulating library in Scotland. The library continued to exist till a comparatively recent period. His first shop, as we learn from the imprint of some of his books, was "at the sign of the Mercury, opposite to Niddry's Wynd"; but in 1726 he removed to a house at the east end of the Luckenbooths, and adopted for his sign the heads of Ben Jonson and Drummond of Hawthornden. In 1721 he published a collection of his poems which was so liberally subscribed for that he is said to have cleared by it 400 guineas. These poems had originally appeared on separate broadsheets and sold for a penny each. In 1724 the first volume of 'The Tea-Table Miscellany,' a collection of songs appeared, which was soon followed by two others. Shortly afterward he brought out 'The Evergreen, being a Collection of Scots Poems wrote by the Ingenious before 1600,' which was equally successful. In 1725 appeared his famous pastoral, 'The Gentle Shepherd.' Its success was instantaneous, and edition followed edition with great rapidity. In 1728 a second quarto volume of his poems appeared; and his 'Thirty Fables,' undoubtedly the best of Ramsay's lesser productions. He was now at the height of his celebrity, and his shop was the common resort of the literary characters and wits of Edinburgh. He spent the last 12 years of his life in a quaint house he had built on the north side of Castle Hill, although he did not give up his shop until within three years of his death. He was buried in Greyfriars' Churchyard, where a monument has been erected. Another monument, erected in 1865, stands in Princes' Street Gardens. Consult 'Life' by Smeaton (1890); Graham, 'Scottish Men of Letters in the 18th Century' (1901).

Ramsay, Allan, Scottish portrait painter, son of the preceding: b. Edinburgh 1713; d. Dover 10 Aug. 1784. He studied art in London and in Italy, and by 1758 had achieved a high reputation. George III. appointed him principal court painter. Walpole regarded some of his portraits of women superior to Reynolds'. He painted portraits of Gibbon, Chesterfield, Hume, Rousseau, and many others, now in the National Portrait Gallery and the gallery at Edinburgh.

Ramsay, Sir Andrew Crombie, Scottish geologist: b. Glasgow, Scotland, 31 Jan. 1841; d. Anglesey, England, 9 Dec. 1891. In 1841 he joined the geological survey, with which he was connected until 1881. He became professor of geology at University College, London, in 1848; was lecturer at the School of Mines 1851; president of the Geological Society 1862; and director-general of the Geological Survey and the Museum of Practical Geology 1872–81. He was popular as a lecturer, and held the theory that many lake basins are the result of glacial excavations. As a geologist he devoted himself to stratigraphy to the exclusion of palæontology and petrography. His works include: 'Old Glaciers of North Wales and Switzerland' (1860); 'The Physical Geology and Geography of Great Britain' (1872); etc.

Ramsay, Andrew Michael (Chevalier Ramsay), Scottish scholar: b. Ayr, Scotland, 9 June 1686; d. Saint Germain-en-Laye, France, 6 May 1743. He was educated at the universities of Edinburgh and Saint Andrews and being deeply interested in theological matters he went to Leyden where he formed a friendship with the mystic Poiret through whom he visited Fenelon, archbishop of Cambrai, in France in 1710. The latter took a deep interest in Ramsay, succeeded in converting him to the Roman Catholic faith, and kept him with him until his death in 1715 when he bequeathed to Ramsay his papers. Ramsay then became tutor to the Duc de Château-Thierry and subsequently acted in the same capacity to the sons of the Pretender, Francis Edward, at Rome. He visited England in 1730, was elected to the Royal Society and on his return to Paris became tutor to the Vicomte de Turenne. His writings were published in excellent French, but though of considerable merit and very popular in his day, are now rarely read. They include: 'Essai Philosophique sur le Gouvernment Civil' (1721); 'Vie de Fénelon' (1723); 'Poems' (1728); 'L'Histoire du Vicomte de Turenne' (1735); etc.

Ramsay, David, American physician and historian: b. Lancaster County, Pa., 2 April 1749; d. Charleston, S. C., 8 May 1815. He studied medicine and practised in Charleston, where he soon acquired celebrity. He was a field-surgeon in the Continental army, was elected to the State legislature in 1776, was a prisoner of the British in 1780–1, and in 1772–6 served in the Continental Congress, acting as president in 1775–6. He was a member of the South Carolina legislature in 1801–15 and was president of the State senate when he was killed by a lunatic. He labored zealously with his pen to promote the cause of the American independence, and among his publications are: 'The History of the American Revolution' (1785); 'The Life of Washington' (1789); 'The History of South Carolina' (1809); 'Universal

History Americanized, or an Historical View of the World, from the Earliest Record to the 19th Century' (12 vols. 1816–17); etc.

Ramsay, Edward Bannerman, Scottish Episcopal clergyman: b. Aberdeen 31 Jan. 1793; d. Edinburgh 27 Dec. 1872. He was the son of Alexander Burnett, but adopted the name of his grand-uncle, Sir Alexander Ramsay, by whom he was brought up. Educated at Cambridge, he took holy orders and went to Edinburgh in 1823 as a clergyman of the Scottish Episcopal Church, becoming dean of the diocese in 1846. He is best known by his 'Reminiscences of Scottish Life and Character' (1858), which has had great popularity. Among other works by him are: 'Lectures on Handel' (1862); 'Pulpit Table-Folk' (1868).

Ramsay, Francis Munroe, American naval officer: b. Washington, D. C., 5 April 1835. He was appointed midshipman in 1850, was graduated from the United States Naval Academy in 1856, and in the Civil War participated in the engagements at Haines' Bluff, Yazoo River, Milliken's Bend, and later commanded the gunboat Unadilla of the North Atlantic Squadron. He was superintendent of the United States Naval Academy in 1881–6, was promoted rear-admiral in 1894, served as chief of the Bureau of Navigation in 1889–97; and in the latter year was retired on reaching the age limit.

Ramsay, Nathaniel, American soldier: b. Lancaster County, Pa., 1751; d. 25 Oct. 1817. He was graduated from Princeton in 1767, studied law, was admitted to the bar in 1771, and in 1776 entered the Continental army with rank as lieutenant-colonel. He greatly distinguished himself at the battle of Monmouth in 1778, when he with Colonel Stewart checked the advance of the British while Washington rallied the main army. He was severely wounded, taken prisoner, and held until 1780 when he was shortly afterward retired. With the exception of 1786–7, when he was a member of Congress from Maryland, he saw no further public service.

Ramsay, Sir William, Scotch chemist, nephew of Sir A. C. Ramsay, the geologist: b. Glasgow 2 Oct. 1852. He was educated at Glasgow and Tübingen, was assistant in the "Young" chemical laboratory 1872–4, and at Glasgow University 1874–80, and, after seven years as professor of chemistry at University College, Bristol (six as its principal), in 1887 he became professor of chemistry at University College, London. A member of most of the royal academies, philosophical, physical and chemical societies of the world, he won his chief repute for his study of rare gases and their discovery; with Lord Rayleigh in 1894 he discovered argon (q.v.), and alone isolated helium, krypton, neon and xenon (qq.v.). In the investigation of the nature and properties of radium he took a prominent part, and in November 1903 claimed that he had proof that helium is the gaseous emanation of radium (q.v.). In 1904 he was awarded the Nobel prize in chemistry. He was made K.C.B. in 1902. He wrote 'The Gases of the Atmosphere, the History of their Discovery' (1896).

Ramsay, William Mitchell, Scottish archæologist and historian: b. Glasgow 15 March 1851. He was educated at the universities of Aberdeen, Oxford, and Göttingen, was Oxford traveling student in 1880, and from that date onwards has traveled extensively in Asiatic Turkey. In 1885 he was appointed to the chair of classical archæology at Oxford, and since 1886 has been professor of humanity (Latin) in the University of Aberdeen. He has made a special study of the geography and topography of Asia Minor, and among his works are: 'The Historical Geography of Asia Minor' (1890); 'The Church in the Roman Empire before A.D. 170' (1893), dealing with St. Paul in Asia Minor and the early persecutions of the Christians; 'The Cities and Bishoprics of Phrygia' (1895–7); 'St. Paul the Traveler and the Roman Citizen' (1895); 'Impressions of Turkey' (1897); 'Was Christ Born at Bethlehem?' (1898); 'Historical Commentary on the Epistle to the Galatians' (1899); 'The Education of Christ' (1902).

Ramsden, rămz'dĕn, **Jesse,** English mechanist and optician: b. Halifax, Yorkshire, 6 Oct. 1735; d. Brighton, Sussex, 5 Nov. 1800. He was apprenticed to a cloth-worker, but subsequently applied himself to engraving, and in the course of his employment having to engrave several mathematical instruments, finally constructed them himself. He opened a shop in the Haymarket, whence he removed to Piccadilly, where he remained until his death. Ramsden obtained a premium from the board of longitude for the invention of a machine for the division of mathematical instruments. He also improved the construction of the theodolite, the pyrometer for measuring the dilatation of bodies by heat, the barometer for measuring the height of mountains, the refracting micrometer and transit instrument and quadrant. He made great improvements in Hadley's quadrant and sextant, reducing the limits of error from 5′ to 30″; and procured a patent for an amended equatorial. He was chosen a fellow of the Royal Society in 1786, and such was his reputation that his instruments were bespoken from every part of Europe. He received the Copley medal from the Royal Society in 1795 in recognition of the importance of his various inventions.

Ramseur, răm'sėr, **Stephen Dodson,** American soldier: b. Lincolnton, N. C., 31 May 1837; d. Cedar Creek, Va., 19 Oct. 1864. He was graduated from West Point in 1860 and was assigned to garrison duty at Fortress Monroe. At the outbreak of the Civil War he resigned from the United States army to enter the Confederate service with rank as major of artillery. He served in the peninsular campaign, was later attached to "Stonewall" Jackson's command, performed gallant service at Chancellorsville and at Gettysburg in his capacity of brigadier-general, and was conspicuous for bravery in the battle of the Wilderness. In 1864 he received temporary rank as major-general, was engaged in the Shenandoah campaign, and was fatally wounded at the battle of Cedar Creek, where he was captured while covering the retreat of the Confederate forces.

Ramsey, răm'zĭ, **Alexander,** American politician and cabinet officer: b. near Harrisburg, Pa., 8 Sept. 1815; d. Saint Paul, Minn., 22 April 1903. He took a partial course at Lafayette College (Easton, Pa.), studied law at Carlisle, Pa., was admitted to practice in 1839, in 1841 was elected chief clerk of the Pennsylvania house of representatives, and in 1843–7 was a Whig representative in Congress. In 1848 he was chairman of the Whig State committee, and on 2 April 1849 was appointed governor of Minnesota, established as a territory 3 March 1849. He concluded treaties with the Ojibways and Sioux in 1851, and a second treaty with the Ojibways in 1863. In 1855 he became mayor of Saint Paul, in 1859 was elected governor of the State of Minnesota, being the Republican candidate for the first State campaign, and by re-election held the post until his resignation 10 July 1863. He then served in the United States Senate two terms, ending in 1875. While in the senate he visited France in the effort to secure a cheaper rate of international postage. In 1879–81 he was secretary of war in Hayes' cabinet. He was a leading spirit of the Minnesota Historical Society, of which he was the first president (1849–63). He was the first Civil War governor to offer volunteers to Lincoln.

Ramsgate, rămz'gāt, England, on the Isle of Thanet, in the County of Kent, four miles from Margate, is a seaport and popular seaside resort. It is situated in the valley between chalky cliffs and has a fine stretch of sandy beach. The chief places of interest are the theatre, music-hall, assembly-room, iron promenade pier, and churches. There is an excellent harbor, extensive bathing establishments; of historical interest are: an ancient Anglo-Saxon graveyard on Ossengal Hill, about one mile from the town; Pegwell Bay, the landing place of Hengist and Horsa, and Cliffs' End, where a cross marks that of Saint Augustine. There is some ship-building, rope-making and a considerable fishery.

Ramus, rä'mŭs, **Petrus.** See Ramée, Pierre.

Ra'na. See Frog.

Ranavalo'na III., former queen of Madagascar: b. about 1861. She succeeded her aunt, Ranavalona II., in 1883 and in that year married the prime minister Rainilaiarivony who had been prince consort to her aunt. She was only nominally queen as the government had been controlled by the prime minister since 1864. The French succeeded in establishing a protectorate over the island in 1895, Ranavalona retained a nominal sovereignty until 1897 when the island was declared a French colony and the queen was deposed and exiled to Algeria.

Ranc, räṅk, **Arthur,** French politician and author: b. Poitiers, 20 Dec. 1831; d. 11 Aug. 1908. He was educated at Poitiers; studied law in Paris; became involved in the disorders of the democratic party, was arrested and deported to Africa. Returning to Paris after the amnesty of 1859, he contributed to the 'Courier du Dimanche,' the 'Nain Jaune,' the 'Journal de Paris' and other journals. For certain articles written for the 'Nain Jaune' he was imprisoned for four months. Under Gambetta he became director of police and in 1871 was elected to the National Assembly, but, owing to his disagreement with the arrangements for peace he resigned and was elected a member of the Commune. He resigned from that body on account of its violence. In 1873 he again became a member of the National Assembly. Later he was impeached for the part he had played during the Commune, and in 1875 during his absence in Belgium was condemned to death *in contumaciam.* The amnesty of 1879 allowed his return to France, and in 1881 he became deputy from the Seine and in 1891 a senator. He wrote a political romance, 'Sous l'Empire' (1872), also 'De Bordeaux à Versailles' (1877); 'Le Roman d'une Conspiration' (1868).

Rancagua, rän-kăg'wä, Chile, the capital of the province of O'Higgins, 45 miles by rail south of Santiago. It is an agricultural centre with an active domestic trade. The Spaniards here won an important victory over the revolutionary forces in 1814.

Rancé, räṅ-sā, **Dominique Armand Jean le Bouthillier de,** founder of the reformed order of La Trappe: b. Paris 9 Jan. 1626; d. 26 Oct. 1700. At 11 he was appointed canon of Notre Dame, and at 13 wrote a commentary on the Odes of Anacreon. After being graduated at the Sorbonne, he was ordained priest (1651) and before long was preferred to no fewer than six benefices. Residing at Paris, in receipt of a large income in addition to his private fortune, he gave himself up to a life of dissipation. In 1657, however, a change took place in his manner of life, and he determined to enter the cloister. He disposed of his estate of Veret, near Tours, applying the proceeds to religious purposes, and demitted all his benefices except the priory of Boulogne and the abbey of La Trappe. Retiring to the latter place in 1664, he began the strictest reforms. (See La Trappe.) In consequence of his growing infirmities he resigned his charge of the abbey in 1695. Consult Marsollier, 'Vie de Rancé' (1703); Gaillardin, 'Trappistes' (1844); Pfannenschmidt, 'Geschichte der Trappisten' (1873).

Ranching, a term derived from the Spanish-American word "rancho," originally meaning a place where herdsmen eat and sleep, but gradually extended to mean a grazing farm. Some of these ranches are of vast extent, especially in Old Mexico and in South America, and include hundreds of square miles. In Texas, Colorado and other western States and Territories, also, there are very large ranches, from which come the supplies of cattle for the American and foreign markets. With the growth of population there has been a marked reduction in great individual holdings of land, but some of the cattle-farms are still very extensive. The cattle are herded by a mixed class of men known as cowboys, which includes students from college, rough and honest frontiersmen, and others with a record that has driven them from places where they are better known. It was chiefly from the cowboy element that President Roosevelt recruited his Rough Riders for the Spanish-American war.

The cowboys round up the cattle once or twice a year, when the steers three years old are separated from the main herd and sent to market, and the calves are branded. The cattle of the ranches have been much improved within recent years by crossing with domestic breeds.

Rand, rănd, or **Witwatersrand,** South Africa. See Witwatersrand; Transvaal Colony.

Randall, răn'dạl, **Alexander Williams,** American legislator: b. Ames, N. Y., 31 Oct.

1819; d. Elmira, N. Y., 25 July 1872. He studied law, was admitted to the bar and in 1840 established a law practice at Waukesha, Wis. He was appointed postmaster there and in 1847 was a member of the convention which framed the State constitution. In 1855 he was elected to the State legislature, was judge of the 2d district in 1856, and in 1857-61 was governor of Wisconsin, rendering important aid in raising troops for the Union army. In 1861-2 he served as minister to Italy, was assistant postmaster-general in 1862-6, and postmaster-general in 1866-9. He then retired from public life and engaged in law practice at Elmira until his death.

Randall, Emilius Oviatt, American author: b. Richfield, Ohio, 28 Oct. 1850. He was graduated from Cornell University in 1874, studied law in the Ohio State University; was admitted to the bar in 1890 and became professor of law at the Ohio State University in 1893. He was appointed secretary of the Ohio State Archæological and Historical Society in 1894, and official reporter of the Ohio supreme court in 1895. He was editor of ‹Bench and Bar of Ohio›; ‹Ohio State Reports of the Supreme Court Decisions› (17 vols.); and since 1897 has also edited the ‹Ohio Archæological and Historical Quarterly.› He has written: ‹History of the Separatist Party of Zoar› (1899); ‹History of Blennerhasset› (1899).

Randall, George Morton, American military officer: b. Ohio 8 Oct. 1841. At the outbreak of the Civil War he entered the Union army, where he received a commission as 2d lieutenant. He received steady promotion, was distinguished for gallantry at Antietam and Petersburg, and was mustered out of the volunteer service in 1865 with the rank of lieutenant-colonel. He was commissioned captain in the regular army in that year, promoted colonel in 1890 for gallant services in the Indian warfare in Arizona in 1873-4; commissioned brigadier-general of volunteers at the outbreak of the Spanish war in 1898, and on the reorganization of the regular army in 1901 received rank as brigadier-general.

Randall, James Ryder, American journalist and poet: b. Baltimore, Md., 1 Jan. 1839; d. Augusta, Ga., 14 Jan. 1908. He was educated at Georgetown College, D. C., taught for a while in a Louisiana college, and then turned to journalism. In 1861 he wrote ‹Maryland, My Maryland,› a song which when set to music became, next to ‹Dixie,› the most popular of the Confederate war-songs and is considered by many to be the best American martial lyric. None of his other songs achieved the fame of this, but several of them are of notable excellence. Among them are: ‹Stonewall Jackson,› and ‹There's Life in the Old Land Yet.› After 1866 he was for many years the editor of the ‹Constitutionalist› of Augusta, Georgia.

Randall, Samuel Jackson, American statesman: b. Philadelphia 10 Oct. 1828; d. Washington, D. C., 12 April 1890. Educated in the schools of his native city, he began life as a silk merchant's clerk and later entered into partnership in a firm of wholesale iron merchants. But politics was more attractive to him than business. He served four years as member of the city council and in 1858 was elected to the State senate. He enlisted with the City troop of Philadelphia at the beginning of the Civil War and served under Gen. Thomas' command in the 2d United States cavalry. He was promoted to orderly sergeant, then quartermaster, and finally captain of his company. During the battle of Gettysburg he was advanced to provost-marshal. In 1862 he was elected to Congress and was a member of that body for 28 years. The first eight years of his career in Congress were uneventful; but in the 43d Congress he served with Blaine, Garfield, Banks, and S. S. Cox on the committee on rules, and took the lead in the opposition to the Force Bill in order to defeat its passage as law and secure for himself the leadership of the Democratic party in Congress. He was elected Speaker of the House at the 2d session of the 44th Congress and re-elected by the 45th and 46th; hence it fell to him to preside during the dispute over the Presidential election of 1876. He was not in sympathy with the settlement of the difficulty by means of an electoral commission. Although always a Democrat, he took the opposite view to that of his party on the subject of protection at the period when tariff discussions were uppermost in Congress. He was an indefatigable worker and never shirked the arduous labor of committees, insisting always on economy and honesty in the management of public affairs. Hence he served as an immense safeguard of the national treasury.

Randegger, răn'dĕg-gĕr, **Alberto,** Austro-English composer and conductor: b. Trieste 13 April 1832. He studied pianoforte under Lafont and composition under L. Ricci, and before he was 20 was known as composer of several masses and two ballets. His next work was an opera, ‹Il Lazzarone,› to a libretto by Rossi. He became musical director in various Italian theatres, and brought out his second opera, ‹Bianca Capella,› at Brescia in 1854. In that year he removed to London, where he has since resided, becoming naturalized. He has been teacher and director of the Royal Academy of Music, conductor of Italian opera at Covent Garden, and of concerts at Queen's Hall and the Norwich Festival. A comic opera, ‹The Rival Beauties,› was produced in 1864. He was made Knight of the Crown of Italy in 1892.

Randers, răn'dĕrs, Denmark, in Jutland, eight miles from Randers Fjord, an important port, whose chief exports are butter and eggs; chief imports sugar, petroleum, coal, and iron. Its celebrated gloves, its manufactures of hosiery, cutlery, railway carriages, calico-printing works, and distilleries are the chief industries. Pop. about 22,000.

Randolph, răn'dŏlf, **Alfred Magill,** American Protestant Episcopal bishop: b. Winchester, Va., 31 Aug. 1836. He was graduated at William and Mary College in 1855 and at the Virginia Theological Seminary in 1858, and took priest's orders in 1860. He was rector of St. George's Church, Fredericksburg, Va., 1860-2, chaplain in the Confederate army 1863-5, and rector of Emmanuel Church, Baltimore, Md., 1867-83. In the latter year he was elected coadjutor-bishop of Virginia. In 1892 the diocese was divided and he then became bishop of southern Virginia. He has published ‹Reason, Faith, and Authority in Christianity› (1902).

John Randolph

Randolph, Edmund Jennings, American statesman: b. Williamsburg, Va., 10 Aug. 1753; d. Clarke County, Va., 13 Sept. 1813. He was educated at William and Mary College and afterward admitted to the bar. He was Virginia's first attorney-general, was member of Congress 1779–82 and governor of Virginia 1786–8. He was a member of the convention that framed the Federal constitution, though he did not approve or sign the document when completed. However, he urged Virginia to accept it, feeling the necessity of union of the States. He was a leader in the work of codifying the Virginian laws begun in 1788. In 1789 Washington appointed him attorney-general, and in 1794 he succeeded Jefferson as secretary of state. During the pending of the Jay treaty, Fauchet, the French minister to the United States, sent home some despatches to his country which were intercepted by an English ship and through the English minister were transmitted to Washington. They were kept by the President for eight days before their contents were disclosed to Randolph. Feeling that others had been consulted regarding the matter before he was apprised and that he must consequently be prejudged, he resigned his office after denying the allegations of the despatches. He retired to Virginia and resumed the practice of the law, but his public career was blighted and his memory bore the stain of the accusations against him until his vindication was presented by Moncure D. Conway in an article, ‘A Suppressed Statesman,’ in ‘Lippincott's Magazine’ for September 1887, followed by a biography, ‘Omitted Chapters of History Disclosed in the Life and Papers of Edmund Randolph’ (1888).

Randolph, John, of Roanoke, American statesman: b. Cawsons, Chesterfield County, Va., 2 June 1773; d. Philadelphia 24 June 1833. He was of an old and wealthy Virginia family. His father died young, and his mother married St. George Tucker, who directed his early education. Later he attended the grammar school of William and Mary College; in 1787 went to Princeton for a few months, and the following session to Columbia College, which ended his academic training. In spite of his protestations of ignorance he was well educated, wrote and reasoned well. He read law and began to practise, but entered into politics, and in 1799 was elected to Congress on a platform denouncing the Alien and Sedition laws. Randolph was in the House of Representatives 1799–1813, 1815–17, and 1819–25. He was a member of the Senate 1825–29, and in 1829 was a member of the Virginia Constitutional Convention. In Congress he soon became the leader of the Democratic-Republican opposition, and after the defeat of the Federalists, was the leader of the administration party, but soon fell out with Jefferson, and became an independent with a few followers called «Quids.» Throughout his public career Randolph was a consistent, strict constructionist. In his first speech he advocated a reduction of the «mercenary» army; he led in the impeachment (1804–5) of Justice Chase, of the Federal District Court; he denounced the settlement of the Yazoo frauds; and was the enemy of fraud and corruption in every form. Brought up in the midst of war, he hated it, opposing all measures leading to the War of 1812, and his opposition to the administration cost him his seat in 1813. Returned to Congress in 1815, he strongly opposed the national reaction that followed the War of 1812. He disliked slavery, but denounced the Missouri Compromise as a surrender of principles by both sides. He invented the term «dough faces,» as applied to Northern men who made compromises with slavery for reasons of expediency. He supported Jackson for the Presidency, and denounced the Adams-Clay understanding as «a combination of Puritan and blackleg.» A duel with Clay followed (1825), in which Randolph threw away his fire and offered Clay his hand. In 1830 Jackson appointed him minister to Russia. Resigning because of ill health, Randolph returned to America (1831) and opposed Jackson in the Nullification controversy. Re-elected to Congress in 1832, he died before taking his seat. Randolph was a strange compound of contradictory elements. At times he was a deist; oftener an emotional Christian. He was a farsighted statesman, an eloquent speaker, a master of satire and vindictive; at times he spoke nonsense. Eccentric and irritable in public, he was fond of children and was loved by them. By his will he emancipated his 318 slaves, providing for their support. With clearer vision than most of his contemporaries, he foresaw the grave danger to the South from the slavery question in politics and pointed out the course which that section must follow. He was never married, his fiancée, the beautiful Maria Ward, having broken her engagement with him to marry his cousin, Peyton Randolph. An aristocrat, he believed in the democratic theories of the French Revolution, but admired Edmund Burke. In his later years, his mind was affected by disease and the use of drugs to deaden pain, and by domestic troubles. In personal appearance Randolph was tall, very slender, with a dark, keen face, and long thin fingers, which he pointed or shook at his opponents when speaking. «Little Jack» was a beautiful boy; John Randolph was an ugly man. Consult: Garland, ‘The Life of John Randolph of Roanoke’ (1881); Henry Adams, ‘John Randolph’ (1882); Trent, ‘Southern Statesmen of the Old Régime’ (1898).

Walter L. Fleming,
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Randolph, Peyton, American patriot, president of the 1st Continental Congress: b. Williamsburg 1723; d. Philadelphia 22 Oct. 1775. He was graduated at William and Mary College, and, sent to complete his education in England, studied law at the Temple. In 1748 he became king's attorney for the colony, and the same year was chosen a member of the House of Burgesses. He was chairman of a committee authorized to revise the laws of the colony, and was among the most active and influential members of the assembly. In 1764 the Virginia House of Burgesses voted an address to the king against the passage of the Stamp Act, which Randolph drew up. On 12 April 1766 he was made speaker of the House of Burgesses, and resigned his office of attorney-general. In the measures of opposition to the English he now took a conspicuous part. In March 1773, on the reception of copies of an address and resolution from the Massachusetts assembly, Randolph was prominent in urging instant and bold action. In the convention which met in August 1774, at Williamsburg, he presided, and was one of the delegates elected to the Continental Congress appointed to meet in Philadelphia in the following September. On the assembling of that body he was unanimously elected its president. In 1775 he presided over the second convention of Virginia and was speaker of the House of Burgesses.

Randolph, Thomas, English poet and dramatist: b. Houghton, Northamptonshire, 15 June 1605; d. Blatherwyke, Northamptonshire, 17 March 1635. He was educated at Cambridge, and was admitted to a fellowship, began early to write, and gained the friendship of Shirley and Ben Jonson, who adopted him among his poetic «sons.» He seems to have lived a boisterous life, which was doubtless the cause of his early death. He left a number of bright, fanciful poems, and was author of several dramas successfully performed by the university students. 'Aristippus, or the Jovial Philosopher' and 'The Conceited Peddler' were published in 1630, the first a satire on university education, the latter a monologue in the style of Shakespeare's 'Autolycus.' He also wrote: 'The Muses' Looking Glass' and 'Amyntas,' published posthumously with his poems (1638); and 'Cornelianum Dolium' (1638) and 'Hey for Honesty' (1651) are credited to him. His collected works were edited by Hazlitt (1875).

Randolph, Thomas Jefferson, American legislator: b. Monticello, Albemarle County, Va., 12 Sept. 1792; d. Edge Hill, Albemarle County, Va., 8 Oct. 1875. He was for several years a member of the State legislature of Virginia, where he introduced in 1832 a bill for the gradual abolition of slavery, and in 1842 another for the reform of the taxes, which was passed, and proved of assistance in placing the State on a sound financial basis. In 1851–2 he was a member of the convention for the revision of the Virginia Constitution, in Civil War time was a firm supporter of the Confederacy, and in 1872 presided over the National Democratic convention which nominated Horace Greeley for the presidency. As literary executor he edited the 'Life and Correspondence of Thomas Jefferson' (1829); and he wrote also 'Sixty Years' Reminiscences of the Currency of the United States.'

Randolph, Vt., town in Orange County; on the Central Vermont railroad; about 22 miles south by west of Montpelier. The town includes several villages. It is in an agricultural and lumbering region and its industries are connected largely with farming and lumbering. It has wooden ware factories, flour and lumber mills, and creameries. Its most noted institution is the Randolph State Normal School. It has a free public library. Pop. (1890) 3,232; (1900) 3,141; (1910) 3,191.

Randolph Plan, in American political history, the name given the scheme of a Federal Constitution proposed in the Convention of 1787 by Edmund Randolph of Virginia. It contained 15 resolutions and proposed a correction of the Articles of Confederation; representation by population in two branches of Congress, the first chosen by the people, the second by State Legislatures; congressional control of taxation and commerce; congressional veto of State enactments; that Congress should choose the executive; that the executive with part of the judiciary should have a limited veto on acts of Congress, and other less important provisions. The plan was favorably reported and many of its suggestions were used in the drafting of the Constitution.

Randolph-Macon (mā'kŏn) **System of Colleges and Academies,** a group of five institutions in Virginia, comprising: (1) Randolph-Macon College at Ashland, a college for men; (2) Randolph-Macon Academy at Bedford City; and (3) Randolph-Macon Academy at Front Royal, preparatory schools for boys; (4) Randolph-Macon Woman's College at Lynchburg; (5) Randolph-Macon Institute at Danville, a preparatory school for girls. These institutions are under the control of one board of trustees, which is self-perpetuating. The original institution is the college for men at Ashland, which was established under the auspices of the Methodist Episcopal Church, South, and received its charter from the Virginia legislature in 1830, thus being the oldest Methodist college in America. It was located near Boydton, Mecklenburg County, Va., and opened to students in 1832. The college obtained no permanent endowment until shortly before the Civil War, and was closed during the war. Much of the endowment was also rendered worthless, and the college reopened in 1866 under serious embarrassment. In 1868 its site was changed to Ashland, Va., and since that time its work has been successful and influential. The first of the affiliated schools was the Academy at Bedford City, founded in 1890; the Academy at Front Royal was established in 1892, and the Woman's College in 1893; the Institute at Danville was affiliated with the system in 1897.

The Randolph-Macon College at Ashland offers courses leading to the degrees of A.B. and A.M., graduation with distinction in four subjects additional to those required for the degree of A.B., is required for the degree of A.M. The A.M. courses are elective, and the elective system prevails to a limited degree in the A.B. course. Six students' aid funds are provided, four of which are for ministerial students, and several scholarships, the largest of which has a fund of $10,000. Two literary societies are maintained by the students for literary and oratorical exercises. The buildings include Pace Lecture-Room Building, the Chemical Laboratory, Duncan Memorial Chapel, the Library, the Gymnasium, the Pettyjohn Hall of Science, and eight large dormitories. The library contained in 1910, 11,000 volumes. The grounds and buildings are valued at $95,000; the productive funds amounted to $210,000 in 1910, and the annual income to $19,000. The students numbered 147, and the faculty 18.

The Randolph-Macon Woman's College offers courses leading to the degrees of A.B. and A.M. One year of graduate work in courses elected by the student is required for the master's degree. For the A.B. course the work of the first two years is prescribed, the last two years is largely elective; the electives are arranged in eight groups, one course in each group being the free choice of the student. Courses in music are offered; one course in the history of music is open to all college students and counts toward the A.B. degree; and a completion of the course in either piano, organ or vocal music counts three hours toward the degree. The college occupies two large buildings, the main building and the Jones Memorial Library; the library contained 9,000 volumes in 1910. In 1910 the productive funds amounted to $210,000, the annual income was $158,000. The students numbered 516 and the faculty 42.

Range, (1) in gunnery, the horizontal distance to which a projectile is thrown. Strictly, it is the distance from the muzzle of the gun to the second intersection of the trajectory with the line of sight. A cannon lying horizontally is called the right level or point-blank range; when the muzzle is elevated to 45° it is called the utmost level. (2) In music, the whole ascending or descending series of sounds capable of being produced by a voice or instrument; the compass or register of a voice or instrument. (3) In natural science, the geographical limits within which an animal or plant is now distributed, and the limits in point of time within which it has existed on the globe. The first is called range in space, and the second range in time. In the case of marine animals, as the Mollusca, there is also a range of depth, as measured by the number of fathoms which constitute their superior and inferior limits. (4) As a nautical term: the length of cable a little in excess of the depth of water, ranged on deck ready to run out when the anchor is let go. Also a large cleat in the waist for belaying the sheets and tacks of the courses.

Range Finder. See FORTIFICATION.

Rangeley (rānj'lĭ) **Lakes**, in Maine, near the western boundary; one of the lakes, Umbagog, is on the boundary between Maine and New Hampshire. The principal lakes are Umbagog, Richardson, Molechunkemunk, Mooselucmaguntic, Rangeley, and Kennebago. A number of small bodies of water are connected with the lakes mentioned, and all are joined by short streams. The Rangeley Lakes are the headwaters of Androscoggin River (q.v.). They are noted for the wild and picturesque scenery, and the abundance of fish and game. The region is a favorite summer resort. Two railroads enter this section, one terminating at the town of Rangeley on Rangeley Lake, and the other at Bemis on Mooselucmaguntic Lake.

Ranger, rān'jẽr, **Henry Ward**, American painter: b. Western New York 1858. He never attended an academy of art, but traveled through France, England, and Holland for several years, and returning to the United States was elected Associate of the National Academy of Design. Among his pictures are ‘The Top of the Hill’ (in the Corcoran Gallery); ‘East River Idyll’ (in the Carnegie Gallery); ‘Pasture Lot’; ‘Morning at High Bridge’; ‘Bradley's Mill Pond.’ Other of his pictures are marines, and as a landscape painter his works are fresh, vigorous and finely colored.

Rangoon, rān-goon', Burma, chief town and principal seaport of Lower Burma, on the left bank of the Hlaing or Rangoon River, in the Pegu Division, covers an area of 22 square miles, and is populated by Hindus, Mohammedans and Christians. The town occupies a long stretch of high land, incorporating villas whose spacious grounds lend to certain parts almost a rural aspect. The wide streets are virtually boulevards bordered on either side by trees. The town is of recent growth, dating from about 1852. Among buildings may be mentioned the cathedrals, churches, government buildings, town-hall, law-courts, custom-house, hospital schools and colleges, and museum. The city enjoys most of the modern conveniences, including a good water supply. There is railway communication with Mandalay and Prome. A large foreign and inland commerce is also carried on by waterways. The main exports are rice and timber, besides raw cotton, precious stones, ivory, horns, and a variety of other articles. Cotton and woolen goods, machinery, coals, silk, salt and sugar are imported. The annual exports exceed £10,000,000. Rangoon was built in 1753 by Aloung-Choosa, the founder of the Burmese dynasty, and has since been the scene of many wars between Burmans and Peguans. The British restored it in 1825 to the Burmese, but annexed it in 1852. Pop. about 240,000.

Ranjit Singh, rŭn-jēt' sĭng'h', founder of the Sikh kingdom in the Punjab, India: b. Gujranwala 2 Nov. 1780; d. 27 June 1839. His father was Maha-Singh, sirdar of Sukur-Chukeah. He lost both parents before he was 18, and though wholly without education set vigorously about consolidating and extending his power. At 20 he was appointed governor of Lahore by the Afghan Amir and calculated upon the fanaticism of the Sikhs for establishing his power over them. He secured European officers to organize his army, whose steadfastness and religious zeal Sir William Hunter has compared to the Ironsides of Cromwell. In 1809 he formed an alliance with the English through Charles Metcalfe, defining the Sutlej as the boundary between their respective territories, and to this engagement he always remained loyal. Having removed the danger of English combination with any of his native rivals, he actively pushed forward his conquests until his territory extended to and embraced Múltán on the south, Peshâwar on the west and Kashmír on the north. He obtained from Sháh Shujá, a refugee in Lahore, the Koh-i-núr diamond that had been carried off by Nádir Sháh from Delhi. Dissensions followed his death as none of his sons was capable of continuing his rule. Consult Griffin, ‘Ranjit-Singh’ (1892).

Rank, in the army and navy, a grade of various officers established by law. The highest rank in the American army is general; in the navy, admiral. Next to general is lieutenant-general, then major-general, and next brigadier-general. In time of peace the highest army officer is usually a major-general, the titles of general and lieutenant-general being bestowed only as marks of special distinction. The same conditions apply to the ranks of admiral and vice-admiral. There is at present one admiral, Dewey, and no vice-admiral, the nearest officers in rank being rear-admirals. A bitter controversy between the friends of the late Rear-Admiral Sampson and of Rear-Admiral Schley as to who was in command at the victory of Santiago prevented either from being made vice-admiral. The lowest military commissioned rank is second lieutenant; in the navy, ensign. Brevet rank is the title of a rank superior to that actually held, without its pay or emoluments. At the close of the Civil War nearly all colonels, with good records, were brevetted brigadier-generals.

Ranke, rän'kė, **Leopold von,** German historian: b. Wiehe, Thuringia, 21 Dec. 1795; d. Berlin 23 May 1886. His preliminary education at Donndorf and Schulpforta was followed by courses in theology and philology in Leipsic. From 1818 to 1825 he taught classics in the gymnasium at Frankfort, and then became professor of history at Berlin, largely because of the promise of his ‘History of the Roman and Germanic Peoples from 1494 to 1535,’ of which the first volume appeared in 1824. His coming to Berlin was the beginning of his study of Venetian history, which was chiefly due to his discovery of the valuable Relations of the Venetian ambassadors, a discovery which strengthened his belief in the importance of diplomatic and other documentary material. In 1827 he began the important study of civilization, first entitled ‘Princes and Peoples of Southern Europe in the 16th and 17th Centuries,’ and in its revised form called ‘The Ottomans and the Spanish Monarchy in the 16th and 17th Centuries’ (1877); and in the years immediately following wrote on the Servian Revolution (1829); ‘The Conspiracy against Venice in 1618’ (1831); and the lectures ‘On the History of Italian Poetry’ (1837). To the lectures delivered in 1833 may be dated the rise of the historical school known by his name, which, like the Heidelberg School, was Protestant in sympathy and impulses, but unpartisan in methods; its members include Waitz, best known for his studies of constitutional history, Giesebrecht, who wrote on the German Empire, von Sybel, author of the ‘History of the French Revolution,’ von Sybel's pupils, von Noorden and Maurenbrecher, and Dümmler, one of the editors of the ‘Monumenta Germaniæ,’ and Dove, Ranke's literary executor and one of the editors of volumes 7–9 of the ‘History of the World.’ From 1833 also dates the foundation of the ‘Historisch-Politische Zeitschrift,’ edited by Savigny, Ranke and others, and protesting against the extreme liberalism of the revolution of July; as well as the beginning of Ranke's great history of ‘The Roman Popes in the Last Four Centuries’ (1834–7; 10th ed. 1900), with its clear outline of the varied political and religious influences at work in Rome and its wonderful grasp of the meaning in a philosophic scheme of ‘World-History’ of the Papacy. It was followed and balanced by ‘German History in the Time of the Reformation’ (1839–47; 7th ed. 1894), and ‘Twelve (originally Nine) Books of Prussian History’ (1847–8; revised 1878–9), thus fulfilling in part his function as Prussian historiographer, a post to which he had been appointed in 1841. He was ennobled by the King of Prussia in 1865, and since 1858 had been president of the Munich Historical Commission. His academic activity ceased in 1871, but his work of research, authorship, and revision continued almost to the very day of his death. A monument was erected to him in Wiehe, in 1896.

He wrote ‘French History, Especially in the 16th and 17th Centuries’ (1852–61), ‘English History in the 16th and 17th Centuries’ (1859–67; revised and enlarged 1877–9), and various studies in German history, among which the sympathetic ‘History of Wallenstein’ (1869; 5th ed. 1895) should be mentioned. But of the greatest importance as embodying Ranke's philosophical idea of universal history is the ‘History of the World’ (1880–8; 5th ed. 1896 sqq.), which is marked by thorough research, excellent critical judgment, and sharp, clear, and felicitous characterization, with a poetical vigor of style.

Ranke's complete works were edited by Dove; volumes 53 and 54 contain valuable autobiographical matter. Consult also: Dove's biography in the ‘Allgemeine deutsche Biographie’; sketches by Sybel, in ‘Histor. Zeitschrift,’ vol. 56; Prutz, in ‘Unsere Zeit’ (1886), and his son F. v. Ranke, in ‘Deutsche Revue’ (1903); Lorenz, ‘Ranke, die Generationlehre und der Geschichtsunterricht’ (1891); Guglia, ‘Leopold von Ranke’ (1893); Ritter, ‘Ranke: Seine Geistesentwicklung und seine Geschichtschreibung’ (1896); Nalbandian, ‘Rankes Bildungsjahre und Geschichtsauffassung’ (1901).

Rankin, Jeremiah Eames, American Congregationalist clergyman and educator: b. Thornton, N. H., 2 Jan. 1828; d. Cleveland, Ohio, 28 Nov. 1904. He was graduated from Middlebury College, Vt., in 1848 and entered the ministry, serving in various pastorates in Massachusetts, New York, and New Jersey. From 1889–1903 he was president of Howard University, Washington, D. C., resigning in the latter year. He was the author of numerous hymns, notably ‘God be with You,’ and also published ‘Auld Scotch Mither and other Poems’; ‘Christ His Own Interpreter’; etc.

Rankine, răn'kĭn, **William John MacQuorn,** Scottish scientist: b. Edinburgh 5 July 1820; d. Glasgow 24 Dec. 1872. He entered Edinburgh University, where he gained several prizes in the department of physics; in 1837 he took up civil engineering and in 1842 published his first book, ‘An Experimental Inquiry into the advantage of Cylindrical Wheels on Railways.’ In 1848 he began his researches in the domain of molecular physics, which occupied him at intervals throughout his life and form his chief claim to distinction in the domain of pure science. In 1855 he was appointed to the chair of engineering in Glasgow University, which position he held until his death. He published ‘Manual of the Steam-Engine and other Prime Movers’ (1859); ‘Manual of Civil Engineering’ (1861); ‘Treatise on Shipbuilding, Theoretical and Practical’ (1866); ‘Machinery and Millwork’ (1869). Consult memoir by Tait prefixed to his ‘Miscellaneous Scientific Papers’ (1881).

Ran'ney, William, American artist: b. Middletown, Conn., 9 May 1813; d. West Hoboken, N. J., 18 Nov. 1857. He learned drawing in Brooklyn, N. Y., and at the outbreak of the war with Mexico enlisted with the Texans. During the campaign he made sketches from the picturesque southwestern life, and after his return to Brooklyn, elaborated these into oil paintings of great interest, among which may be mentioned: ‘Boone's First View of the Kentucky’; ‘On the Wing’; ‘Washington on His Mission to the Indians’ (1847); ‘Duck-Shooting’ (Corcoran Gallery, Washington); ‘The Sleigh Ride’; and ‘The Trapper's Last Shot.’

Ransom, Matthew Whitaker, American soldier and legislator: b. Warren County, N. C., 8 Oct. 1826; d. 8 Oct. 1904. He was graduated from the University of North Carolina in 1847, was admitted to the bar the same year, and in 1852 was elected attorney-general but resigned in 1855. He entered political life and in 1858–60 served in the State assembly. He was untiring in his efforts to avert the Civil War, but when North Carolina seceded he entered the Confederate army and served with ability through the war, attaining the rank of major-general in 1865. Afterward he resumed his law practice, was elected United States senator in 1872 and served until 1895, when he was appointed minister to Mexico and served until 1897 when he returned to the United States and re-engaged in law practice at Weldon, N. C.

Ransom, Robert, American soldier: b. Warren County, N. C., about 1828. He was graduated from West Point in 1850, was brevetted 2d lieutenant of dragoons, and served in various parts of the West until appointed assistant instructor of cavalry tactics at West Point. He was made captain of the 1st cavalry 31 Jan. 1861, but resigned on 24 May and entered the Confederate army. He became colonel of the 9th North Carolina Confederate cavalry; in March 1862 was advanced to brigadier-general and on 26 May 1863 to major-general. In 1862 he commanded a brigade and the defenses near Kinston, N. C., and from April to June 1864 the Department of Richmond. He was in command in November 1864 of the subdistrict No. 2 of the department including South Carolina, Georgia, and Florida. Since the close of the war he has been express agent and city marshal of Wilmington, N. C., 1866–7; a farmer in Virginia 1874–8, and latterly a civil engineer in the service of the United States in various river and harbor improvements in Missouri and South Carolina.

Ransom, Thomas Edward Greenfield, American military officer: b. Norwich, Vt., 29 Nov. 1834; d. Rome, Ga., 29 Oct. 1864. He was educated at the Norwich University, studied civil engineering, and settled in Illinois, where he engaged as a civil engineer and a real estate agent. After the outbreak of the Civil War he became a lieutenant-colonel of volunteers in July 1861, and commanded a regiment at Shiloh in April 1862. He was promoted brigadier-general in January 1863; served under General Banks in the Red River expedition; and later joined Sheridan's army, took command of a division just before the capture of Atlanta, 2 Sept. 1864, and died as a result of overtaxing his strength while leading his troops in pursuit of Hood.

Ransom (from Latin, *redemptio*), the sum required to be paid to the captors of a prisoner of war in order to procure his release. The practice of redeeming prisoners of war by a ransom was a very common one not only in ancient times, but in modern times up to the end of the 18th century. As late as 1780 a treaty was concluded between France and Great Britain on the subject of exchange of prisoners, in which the various relations the different ranks bore to each other were specified, together with the sums required to be paid by way of ransom. A French vice-admiral or an English admiral was estimated as of equivalent value in the exchange of prisoners to 60 sailors or private soldiers, as was also a French marshal or an English field-marshal. Ransom is now exacted only by brigands. Prisoners are generally retained until peace is restored, when they are released without ransom; or they may be exchanged during the progress of hostilities. Officers are frequently released during the war on pledging their word of honor to take no further active share in it.

Ransome, răn'sŭm, **Arthur,** English physician: b. Manchester 11 Feb. 1834. He was educated at Trinity College, Dublin, Caius College, Cambridge, and studied medicine in London and Paris. He was lecturer on biology at Cambridge in 1857–61, professor of hygiene at Owens College in 1880–95, became lecturer on phthisis at the College of Physicians in 1890, and is a recognized authority in pulmonary diseases. He has published: 'Stethometry' (1876); 'Causes of Consumption' (1884); 'The Principles of Open Air Treatment of Phthisis and Sanatorium Construction' (1903); etc.

Ranters, a term not in use in the United States, but formerly applied in England to the Primitive Methodists, on account of the enthusiasm and earnestness which characterized their worship. While this is the recent application of the word, it was formerly used in the period of the English Commonwealth to indicate an alleged sect whose practices attracted public reprobation, and which was suppressed by the authorities.

Rantoul, răn'tool, **Robert, Jr.,** American statesman: b. Beverly, Mass., 13 May 1805; d. Washington, D. C., 7 Aug. 1852. His father, who survived him for several years, was long a member of the State legislature. The son was educated at Harvard where he was graduated in 1826. He studied law in Salem, was admitted to the Essex bar in 1827, and for several years practised in Gloucester, which he represented in the legislature 1834–7 and distinguished himself there as a reformer and an advocate of the rights and interests of the common people. He exerted himself for the abolition of capital punishment, and made a report to the legislature on that subject. In 1837 he was appointed a member of the Massachusetts board of education, and gave much time and attention to the advancement of the system of public instruction. In 1843 he became collector of the port of Boston, and in 1845 was made United States district attorney. In 1851 he was elected United States senator to succeed Daniel Webster for the short remainder of his term; and having been prominent among opponents of the extension of slavery, the free-soilers of his district united with the Democrats in electing him to the United States house of representatives the same year. A volume of his speeches and writings with memoir appeared in 1854.

Ranuncula'ceæ, an order of herbs and shrubs. There are about 700 species, widely distributed in cold and temperate climates, and to a very limited extent in warm ones. All are more or less acrid while fresh, but usually lose this property upon being dried. A few have been reputed poisonous, others have been used in medicine, and several for food both for man and animals. The order is, however, chiefly noted for its ornamental species, many of which are widely popular garden flowers. The best known of these genera are probably *Aquilegia, Clematis, Anemone, Delphinium, Helleborus, Pæonia, Nigella, Caltha, Aconitum, Actæa,* and *Ranunculus.* (See COLUMBINE; ANEMONE; LARKSPUR; PEONY; CLEMATIS; HELLEBORE). The type genus, *Ranunculus,* which includes about 200 species, is also cultivated. The garden or Asiatic ranunculus (*R. asiaticus*) is a native of western Asia, and has been cultivated for about 300 years for its brilliant single or double variously colored flowers. The lesser celandine (*R. ficaria*), a European species, is cultivated for its foliage, which is eaten like spinach, and for its tubers, which are served like potatoes. Several species of buttercups, notably *R. acris* and *R. repens,* are well-known weeds in pastures.

Ranz des Vaches, räṅs dā väsh, the name of the national air which the herdsmen of the Alps in Switzerland sing or play on an instrument called the Alpenhorn, or horn of the Alps, when they drive out the herds. It consists of a few simple intervals, yet capable of producing a very striking effect in the echoes of the mountains. See NATIONAL HYMNS.

Raoul Rochette, rä-ool rō-shĕt. See ROCHETTE, DÉSIRÉ RAOUL.

Raoult, rä-oo, **François Marie,** French chemist: b. Fournes, Nord, 10 May 1830; d. 1901. He was educated in Paris, where he received the doctorate in physical sciences in 1863. He went to the University of Grenoble to teach chemistry, was made professor in 1870 and dean of the faculty in 1889. In 1890 he was made correspondent of the Academy of Sciences. His researches were first in the field of electro-chemistry; later he turned to the discovery of the freezing-point of a great number of solutions and also the determination of the tension of vapors of volatile liquids.

Raoux, rä-oo, **Jean,** French painter: b. Montpellier 12 June 1677; d. Paris 10 Feb. 1734. He painted history, portraits and genre, and during his lifetime enjoyed a great reputation in France and was even elected to the Academy (1717). He has indeed painted some good landscapes in the style of Claude Lorraine, but his historical pictures are stagy and artificial. His portraits are said to have been good likenesses, and he is chiefly known nowadays for his portraits of fine ladies, on whom he bestowed the false and meretricious graces fashionable in his day. Many of his pictures were engraved.

Rap, familiar in the phrase «not worth a rap,» a counterfeit Irish coin of the time of George I., which passed for a half-penny, though not really worth a fourth of that value. There was also a small Swiss coin called «rappen,» worth a centime.

Rape, an annual herb (*Brassica napus*) of the order Cruciferæ. It is a native of the Old World, where it has long been cultivated for its foliage and its seed, the former of which is an important stock food, the latter, a source of coleseed oil. It resembles the turnip in foliage, but grows taller and lacks the turnip-like root. In America it is not grown for its seed at all, but toward the end of the 19th century became an important soiling and forage crop for sheep, and beef cattle. It is usually sown after midsummer upon any good soil, and is especially popular in cool climates because it will stand considerable cold without injury.

Rape, a word derived from German «raffen» and old English «rap,» to seize and carry away, and meaning in law the crime of having carnal knowledge of a woman without her consent and by force. This has always been regarded as one of the highest crimes, and is still punished by death in some American States; in others by long terms of imprisonment. In the case of a female who has reached the age of consent, and who is not an idiot, the element of force is essential to constitute the crime of rape. If consent is obtained by the use of threats which convince the woman that it would be useless to resist, it is not necessary to prove actual violence. It has long been established by court decisions in England and America that deception, as when a married woman is deceived into believing that a man not her husband is her husband, does not constitute rape. Within the past 20 years statutes have been passed in England and many of the United States raising the age of consent for girls to 16 years. These laws have been of great service in protecting the young and promoting morality.

Raphael Santi, rä'fä-ĕl săn'tē (called by the Italians RAFFAELLE and RAFFAELLO, but generally in his own writings and in the signing of his pictures, RAPHAEL), Italian painter: b. Urbino in Umbria 28 March 1483; d. Rome 6 April 1520. The mountain town of Urbino was the capital of the ancient duchy of the same name, which came to an end in 1626. The castle or palace of the Duke is still a building of extreme interest; and there is evidence that during the lifetime of Frederigo and Guidobaldo — who reigned during the years of Raphael's youth — the palace was one of the most remarkable museums in Italy, being crowded with works of art both of antique and of Renaissance production.

The young Raphael was allowed to devote himself to art the more readily that his father (Giovanni) was himself a painter. It seems that the family had lost property; and there is much in the record concerning Raphael to indicate the existence in his character of traditions of elegant life and that kind of sympathy which comes from ancestral cultivation. At a very early age for a student of art he entered the workshop of Perugino; his possibly earlier studies with Timoteo Viti being of little consequence to his artistic growth. It is asserted that the young man went to Siena, where Pinturicchio was at work; but this is doubtful, and it is only important because there has been so much question about the true influence which at first determined or modified Raphael's career. It was as early as 1504 that he first went to Florence, and the artists who would then have influenced him the most were Leonardo da Vinci and Michelangelo; because while the earlier Florentines would be more immediately recognized by him as painters of the ancient and traditional manner, it is clear from his subsequent history that he was more quick than any other man would have been to adapt himself to the larger conditions of a new world of art. The first absolutely modern painting may be said to have come into existence with Leonardo da

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Vinci, although that great master allowed himself but little time to devote to executive work, and has left us almost nothing by which we can judge his full strength. As for Michelangelo (eight years Raphael's senior, and as precocious), his work must have revealed to Raphael the possibilities of magnificent design in which the human body is treated as the principal subject, without important assistance in the way of draperies, backgrounds, or even narrative subject, as a work of art.

The earliest painting which can be ascribed to Raphael with some certainty, is the Marriage or Betrothal of the Virgin (called 'Lo Sposalizio') at the Brera Gallery in Milan. This picture shows the Umbrian feeling, and has many resemblances to the full manner of Perugino, Raphael's master; but it is significant that no serious attempt has been made to dispute the ascription of it to Raphael himself, so great is the resemblance in the peculiar grace of its composition to the more mature works of the younger man. The most important record we have of his earliest stay in Florence, ending with his 25th year, is the Madonna with Saints in the National Gallery, commonly known as the 'Ansidei Madonna,' which, however, is thought to have been painted during a visit which he made to Perugia; and other Madonnas, such as that in the Pitti Palace, called the 'Madonna del Gran' Duca,' and the 'Madonna with the Goldfinch' in the Uffizi; as well as a picture in the Louvre Museum at Paris, called 'La Belle Jardinière.' This epoch, however, was one of constant production, and there are many smaller paintings, only less important, than those named above, which may with considerable certainty be given to this period, namely, the years of his life from 20 to 25. It was in 1508 that he went to Rome.

It does not appear that Raphael was sent for directly by the order of Pope Julius II., but he began work there almost immediately on his arrival, and indeed the first of the famous halls in the Vatican which are covered with his paintings was completed, nearly as we see it now, as early as 1511. This room, known as the Camera della Segnatura, or Chamber of the Signature, is a hall roofed with a solid masonry vault, having one large window turned nearly to the north and lighting the room fairly well on bright days. On the west wall is the famous painting known as the 'Disputa del Sacramento,' which should properly be called in English 'The Glory or the Triumph of Religion'; and opposite this to the east is the 'School of Athens.' Over the window is the Parnassus presided over by Apollo; and opposite the window is, in the lunette, the magnificent 'Jurisprudence'; while below this and on either side of the deep niche serving as the recess of a window now condemned, are paintings having to do with the Papal authority in earthly and spiritual things. Similar paintings adorn the dado beneath the great pictures, and the vault itself is covered with work by Raphael's own hand; in fact, lovers of Raphael's painting, considered by itself and without reference to its historical importance, have always found the Camera della Segnatura the most delightful place for the study of the master's individuality. There is every reason to suppose that the greater part of the work here is due to his own touch; the employment of assistants being much less probable here than in later works.

When this first series of important wall paintings was completed, Raphael was 28 years old, and he had only nine years to live. During those nine years were produced the paintings in the four large rooms in the Vatican adjoining the Camera della Segnatura, and also the decorative frescoes in the Farnesina Palace, the outdoor corridors and vaulted galleries fronting the Cortile di S. Damaso in the Vatican, which are known as the Loggie di Raffaelle, and also a great number of easel pictures in oil, portraits, religious pictures sent as presents to the king of France and other foreign princes, and, toward the close of his life, two pictures of peculiar importance in his history, because they have always excited so much general admiration. These are the 'Madonna di San Sisto,' now in the royal collection at Dresden, and 'The Transfiguration,' left unfinished at his death, and now in the picture gallery of the Vatican. Raphael also made some designs, or at least undertook some superintendence as architect, especially in connection with the Church of Saint Peter, and as designer of several palazzi, or stately mansions, in and near Rome. The excavations going on among the ruins of Rome also excited his interest and took up much of his time. He was surrounded by assistant artists who worked with him or for him, under his general direction and also from his studies and under his immediate control. It is now impossible to discriminate between these different ways of work, except by means of the internal evidence of more or less characteristic handling in the painting. Thus it is generally agreed that the large frescoes of the battle at the Milvian bridge and the other paintings in the Stanza di Constantino are almost wholly by the hand of his assistants; while those in the Stanza dell' Incendio and in the Stanza dell' Eliodoro are, though not wholly by the hand of Raphael, his work as to their general designs, as to their composition both in mass and in color, and largely his own creation. The remarkable fact concerning these and the smaller paintings is that they all, except some of those in the Constantine series, belong to that well-known family or class of works which have become familiar to all the European world, as typical pictures by the artist who is generally accepted as the first of religious painters, while at the same time his name is used by artistic reformers as a symbol of the commencement of the decline of art.

His work shows little interest in realization of incident or of action; he is regardless of the impossibilities of the Apostles in long and voluminous robes, and of men in a fishing boat much too small for them — indifferent to the contradictions of the famous picture of 'The Conflagration in the Suburb' ('Incendio del Borgo'), where flames are seen flickering among marble columns and walls of cut stone without anything to feed them; and yet this lack of realism in his designs has never diminished his vast popularity, as the typical painter toward whose work everyone turns when there is mention of Christian religious painting. There is no better instance of the purely artistic quality obtaining full recognition in spite of the absence of those qualities which are generally considered more popular; the main reason for this is in the extraordinarily perfect composition in line and in mass, the figures filling the chosen oblong or the lunette or the circle in so many of his compositions, with absolutely faultless harmony, producing the desired result — a picture of entirely harmonious effect. As a colorist, he is not one of those painters to whom glow and splendor of hue is the important thing, who deem design in color supreme, as do Correggio and the great Venetians from the time of Vivarini to that of Tiepolo; but invested his noble linear compositions with a coloring wholly agreeable, never violent, always satisfactory to the student of sentiment in art, and to the lover of noble composition — those students being more numerous in the world than the lovers of color for its own sake.

Consult: Passavant, ‘Rafael und sein Vater’; Eugene Müntz, ‘Raphaël, sa vie son Œuvre et son temps’ (1881); ‘Les Historiens et les Critiques de Raphaël’ (1883); Crowe and Cavalcaselle, ‘Raphael, his Life and Works’ (1882); Bigot, ‘Raphael and the Villa Farnesina’ (1884).

Russell Sturgis.

Raphael Ware. See Majolica.

Raphall, Morris Jacob, American rabbi and author: b. Stockholm, Sweden, September 1798; d. New York 23 June 1868. In 1812 after receiving rabbinical education at Copenhagen, he went to England to study its language and literature, and after a continental tour spent three years at the University of Giessen, returning to England in 1825. In 1832 he lectured on post-Biblical history in London, in 1834 began a ‘Hebrew Review and Magazine of Rabbinical Literature,’ which he edited with much scholarship, was associated with D. A. De Sola in a translation of 18 treatises of the ‘Mishna,’ and with Messrs. De Sola and J. L. Lindenthal in a commentary on Genesis. In 1841 he was elected rabbi of the Birmingham Synagogue and in 1849 was called to the Congregation B'nai Jeshurun of New York, where he remained until his death. In 1855 he published his ‘Post-Biblical History of the Jews.’ In addition he wrote some learned pamphlets and was a contributor to ‘The Jewish Messenger.’ His defense of slavery from the biblical standpoint (‘The Bible View of Slavery’) aroused much controversy in the early days of the Civil War.

Rapha'nia, another name for the disease called ergotism (q.v.).

Raphia, a genus of low African palms with oval, gigantic pinnate leaves, and fruit spikes often weighing from 200 to 300 pounds. See Palms.

Rapid-fire Guns. See Ordnance.

Ra'pier, a sword-like weapon, light, highly tempered, edgeless and finely pointed. It is about three feet in length, and was long a favorite weapon for dueling.

Rapin de Thoyras, rä-păṅ dė toi-rä, **Paul,** French historian: b. Castres, Languedoc, 1661; d. Wesel, Duchy of Cleves, 1725. He studied at the Protestant Academy of Saumur, and was admitted an advocate in 1679. The revocation of the Edict of Nantes, however, drove him to England in 1686, and subsequently to Holland, where he entered a company of French cadets. In 1689 he followed the Prince of Orange and distinguished himself at the battle of the Boyne. In 1707 he settled at Wesel and devoted himself to historical composition. His great work, ‘L'Histoire d'Angleterre’ (1724), was very animated, but impartial, and contains much solid information. The style is clear, the facts are methodically arranged, and he is always careful to cite his authorities. It embraces the period from the invasion of the Romans to the accession of William and Mary, but continuations by other pens were afterward added.

Rapp, räp **(Johann) George,** German sectary, founder of the communistic society called Harmonites: b. Iptingen, Würtemberg, 1 Nov. 1757; d. Economy, Pa., 7 Aug. 1847. He studied in the village school, became a linen weaver, and even before 1783, when he married, had religious doubts and visions, and dated his "complete surrender" from the year 1782. His peculiar religious ideas were so tinged with political socialism that his followers were persecuted by the German government; and in 1803 he emigrated. In the next year he founded at Harmony, near Pittsburg, a communistic colony, where work, unity, equality, and celibacy were the rule. A new colony, called New Harmony, was founded on the Wabash in Posey County, Ind., in 1815 and was sold to Robert Owen (q.v.) in 1824 when Rapp and his followers returned to Pennsylvania, founding on the Ohio River the town of Economy (q.v.). Consult: Nordhoff, ‘Communistic Societies of the United States’ (1875); Knortz, ‘Die Christlich-kommunistische Kolonie der Rappisten’ (1892).

Rapp, Jean, Count of, French general: b. Colmar, Alsace, 27 April 1772; d. near Lorrach, Baden, 8 Nov. 1821. In 1788 he entered the military service, accompanied Desaix during the campaigns in Germany and Egypt, and after Desaix had fallen at Marengo, became aide to Bonaparte. On the breaking out of the war against Austria, in 1805, he accompanied Napoleon, and after the battle of Austerlitz, where he threw the Russian guards into confusion by a bold attack with his cavalry, he was made brigadier-general. For distinguished service done in 1809 he was created a count of the empire, and in 1811 received the cross of grand officer of the Legion of Honor. He was seven years commander of Dantzic, which he defended after the retreat of the French army from Russia, till 1814, during a severe siege of nearly a year, in which he displayed great talent and brilliant courage, and not till all means of defense were exhausted, and he was compelled by famine, did he capitulate. Returning to France in 1814, he was received with distinction by Louis XVIII., and in March 1815, was sent against Napoleon. But when the defection of the whole army rendered all resistance impossible, Rapp also went over to Napoleon, who made him commander of the army of the Rhine. When Louis XVIII. returned a second time to Paris Rapp was pardoned, and retained the command of the 5th division, granted him by Napoleon, till the army was disbanded. After his death appeared the interesting ‘Mémoires du General Rapp, écrits par lui-même’ (1823). Consult: Spach, ‘Le Général Rapp’ (1856).

Rapp, Wilhelm, German American journalist: b. Germany 14 July 1828; d. 1 March

1907. He was an active participant in the German revolutionary movement of 1848, and in 1852 emigrated to the United States where he took up journalism as his occupation. He was the successful editor of the 'Turnzeitung' of Philadelphia and Cincinnati, the 'Baltimore Waechter' (1857–61), (1866–72), and the 'Illinois Staats Zeitung' of Chicago (1861–6), and again from 1891. He wrote 'Recollections of the German Fatherland by a German-American.'

Rappahannock, răp-ạ-hăn'ŏk, a river of Virginia, formed by several small streams which have their rise in the Blue Ridge. It flows east-southeast into the Chesapeake Bay, which it enters about 25 miles below the Potomac. It is about 250 miles long and is navigable over 90 miles from its mouth. The upper part of its course is through a mountainous country, where it is a swiftly flowing stream with many rapids and low falls. At Fredericksburg (q.v.) is a fall which furnishes extensive water power. From Fredericksburg the river becomes a tidal stream, and the broad, long estuary which enters the bay is navigable for the largest steamers. The name of the Rappahannock is associated with many of the events of the Civil War.

Rappahannock Station, Battle of. In the fore part of Ocober 1863 Gen. Lee maneuvered the Army of the Potomac, under Gen. Meade, from the Rappahannock River back to Centreville. Meade resumed the offensive 19 October, and in several encounters pressed Lee back to the Rappahannock, Lee crossing to the south side of the river and disposing his army on both sides of the Orange and Alexandria Railroad, Ewell's corps on the right and A. P. Hill's on the left, with cavalry on both flanks. A part of Ewell's corps was left on the north side of the river at Rappahannock Station, in an intrenched position covering the pontoon-bridge, the railroad bridge having been destroyed. The position was first held by Gen. Hays' brigade and four guns, to which was subsequently added Gen. Hoke's brigade, under Col. A. C. Goodwin. The whole force numbered about 2,000 men. Lee had destroyed the railroad from Bristoe Station to the Rappahannock, a distance of more than 20 miles, and this had to be rebuilt before Meade could follow to the river. It was completed as far as Warrenton Junction on 2 November; supplies were brought up; and on the morning of the 7th Meade advanced to cross the Rappahannock. Gen. French, with the left wing of the army, moved upon Kelly's Ford, five miles below Rappahannock Station, and forced a passage of the river (see Kelly's Ford, Engagements at), while the Fifth and Sixth corps, under command of Gen. Sedgwick, moved along the line of the railroad, forming line about midday within one and a half miles of Rappahannock Station, the right of the Fifth corps and the left of the Sixth on the railroad. Skirmishers were thrown forward and the Confederate position reconnoitered, and as soon as it could be ascertained a plan of attack was formed. The works to be carried consisted of two redoubts, connected by a chain of rifle-pits, and a further line of rifle-pits ran from the left redoubt to the river and some distance along it. The Fifth corps was to gain the river bank on the left, and the Sixth on the right, in order to establish artillery on a range of high ground in front of the works and drive the men from them. The river bank was gained both on the right and left, artillery put in position, and the works shelled, but at dusk no impression had been made, the Confederate guns had not been silenced, nor had the infantry been driven from the works. Gen. Russell, temporarily commanding Wright's division of the Sixth corps, said that he could carry the works by assault, and he was ordered to do it. It was now after dusk; artillery fire was kept up; Russell led parts of Ellmaker's and Upton's brigades, in all 2,117 men and, under a heavy fire of musketry and canister, went over the works in a very few minutes, capturing 1,303 officers and men, the four guns, 1,225 stands of arms, and seven battle-flags. A part of the Fifth corps on the left joined in the assault. Gen. Wright says in his report that this was the first case during the war of an intrenched position being carried on the first assault, and one of Gen. Lee's biographers writes that it was the saddest chapter in the history of the Army of Northern Virginia. Gen. Hays, with nearly 300 of his men and about 130 of Hoke's, escaped. The Union loss was 413 killed and wounded, and six missing. Gen. Lee reports his loss as 6 killed, 39 wounded, and 1,629 captured or missing, some of the missing being probably killed or wounded. Lee now abandoned his design of attacking Gen. French, who had crossed at Kelly's Ford, burned the end of the pontoon-bridge remaining in his possession, the north end of it having been captured by Russell, and fell back during the night to Mountain Run. Gen. Meade crossed the remainder of his army over the Rappahannock on the 8th and moved to Brandy Station, and Lee crossed to the south side of the Rapidan. Consult: 'Official Records,' Vol. XXVI.; Humphreys, 'From Gettysburg to the Rapidan'; the Century Company's 'Battles and Leaders of the Civil War,' Vol. IV.

E. A. Carman.

Rap'pists. See Harmonists.

Rapto'res, an old name in classification, variously limited, for the predatory birds. See Birds of Prey.

Raratonga, rä-rä-tŏng'gä, or **Rarotonga,** an island in the South Pacific Ocean, belonging to the group of Cook Islands (q.v.).

Rarey, John S., American horse tamer: b. Franklin County, Ohio, 1828; d. Cleveland, Ohio, 4 Oct. 1866. In early life he showed a marked fondness for horses and skill in their management, which he later developed by study and close association with them. In 1856 he went to Texas to further his knowledge and upon his return to Ohio engaged in startling exhibitions of his skill. In training or taming the horse his methods were always prompted by a humane spirit, the use of the lash not being resorted to unless in extreme cases. In 1861 he visited England, Russia and other European countries, where his mastery over the wildest steeds amazed and delighted his vast audiences.

Rar'itan, a river in New Jersey, the headwaters of which are in the northern part of the State. It enters Lower New York Bay through Raritan Bay. The latter is really the broad mouth of the Raritan River. The river is navigable to Brunswick Landing, about two miles above New Brunswick.

Rascal Leaf-crumpler, the leaf-folding caterpillar of a phyticid moth injurious to many American fruit-trees, as the apple, cherry, plum (qq.v.), etc.

Rash, an eruption on the skin. The commonest rashes are those of the specific fevers, the crimson rash of measles, the scarlet rash of scarlet fever, the rose-spots of typhoid fever, etc. But there are also numerous eruptions due to disordered states of the body, and apart altogether from any infectious disease; such are nettle-rash and the like.

Rashi, rä'shē, properly **Rabbi Salomon-Ben-Isaak,** sometimes erroneously called **Jarchi,** the most famous of French rabbins: b. Troyes about 1040; d. 1105. Entering the Jewish school in Worms he made astonishing progress in ancient languages, philosophy, medicine, and astronomy. His skill in explaining the Holy Scriptures and the Talmud was so remarkable that his contemporaries honored him with the titles of interpreter of the law and prince of interpreters. To satisfy his longings after knowledge he undertook an extensive tour through Italy, Greece, Palestine, Egypt, Persia, and Germany, where he was particular in visiting the towns which possessed learned Jewish schools. The literary treasures thus collected he introduced into his writings, which were received at the time with the greatest enthusiasm, and are still held in high estimation. His most famous work is a commentary on the Pentateuch. He also wrote commentaries on the prophets, the Tälmud, and various treatises on miscellaneous subjects. Consult: Zunz, 'Zeitschrift für die Wissenschaft des Judenthums' (1822).

Rask, räsk, **Rasmus Christian,** Danish scholar: b. Brendekilde, island of Funen, 22 Nov. 1787; d. Copenhagen 14 Nov. 1832. He studied at the University of Copenhagen, undertook a journey to Sweden and Russia, to increase his acquaintance with the northern languages; and in 1808, after a two years' stay in Iceland became assistant in the academical library of Copenhagen. His fame as a linguist is founded upon such works as 'An Introduction to the Knowledge of the Icelandic or Old Norse Tongue' (1811); an edition of Biörnonis Haldorsen's 'Icelandic Dictionary' (1817); 'Instruction in the Anglo-Saxon Tongue'; and 'Researches as to the Origin of the Old Norse or Icelandic.' In 1822 he was appointed professor of literary history at the University of Copenhagen, and subsequently professor of Oriental languages and librarian to the university. During this period he published, among other works, a Spanish Grammar; 'Instruction in the Friesland Tongue'; 'On the Antiquity and Genuineness of the Zendavesta.'

Raskol'niks, or **Rascolnicians,** the name applied collectively to all the dissenters from the orthodox church of Russia, the Greek-Eastern Church. The schism, or *raskol,* was affected at two different times principally; first during the 17th century upon the occasion of the revision of the Testaments by Patriarch Nikon (1652–8) at Moscow; and upon the further revision and the usurpation of secular powers by Peter the Great (1689–1725). On both these occasions great bodies of Raskolniks, refusing to comply with the reforms instituted, left the church and set up their own religious communities. The general characteristic of all the Raskolniks is conservatism. Differing from the English dissenters who have usually instituted some reform in the creed or the ritual of the body from which they seceded, the Raskolniks secede because they wish to cling to their old customs and beliefs and do not agree to innovations in the orthodox church.

The Raskolniks are of two great classes, each of which is subdivided with endless schisms, and dissenting sects, more or less antagonistic to each other. The Popovtzi, those who have priests, *pops,* in Russian; and the Bezpopovtzi, or those who have no priests. Of these the Bezpopovtzi are the more numerous, the most aggressive and the least conservative.

The Popovtzi have not changed from the beliefs of their old church. They are, for the most, inoffensive and tolerant, and have lately been treated by the state with less severity than before. Under Alexander II. they were allowed to reopen their churches and to build new ones. A certain measure of civic rights was also granted them, together with liberty of religious services. This branch of the Popovtzi, known as the Edinovertzi, have a bishop, who resides at Moscow. Another and much smaller class denounce the Czar and the Established Church and for that reason are treated as dangerous fanatics.

The Bezpopovtzi are much more inimical to the State and the Church. They believe that the present age is one of the anti-Christ, that the authorities to-day, both temporal and spiritual, are his servants and that therefore it would be sin to recognize their authority. They have no priests among themselves, as they believe that every Christian is a priest, in support of which they quote Rev. i. 6, and that churches are unnecessary, since a Christian's body is a temple, based upon 1 Cor. iii. 16. Some of the principal sects of the Bezpopovtzi are: Doukhobors (q.v.), who in some respects resemble the early Quakers; the Vozdykhantzi, who hold that the world at present is under the reign of the Holy Ghost, whom they worship by prayers and sighing; the Philippines, who observe only two sacraments, the Lord's Supper and Baptism; the Stranniki, who believe the promises of the Lord concerning the Church are already fulfilled and that we are living in the first era of the resurrection; the Molokaneh and the Obschie (the latter being communists), who reject all external rites; and the anarchistic Khlisti and Skoptzi. These latter two sects are the most feared and hated by the Russian Church and State. The Khlisti are ascetics and practise many fanatical rites under the direction of their prophets and prophetesses, one being that of bodily scourge. The Skoptzi carry the beliefs of the Khlisti to an even greater extreme, mutilating their bodies in horrible manner in the frenzy of their rites. The Khlisti and Skoptzi are treated as criminals and transported to Siberia by the government; other sects of the Bezpopovtzi are denied many of the civil rights enjoyed by the Popovtzi, are closely watched by the police and are much feared by the government.

The Raskolniks, as a whole, are not allowed to worship in public except in their own chapels and churches, which latter must be of distinctly different appearance from the Eastern-Greek churches; they are not allowed to propagate their beliefs, to open their convents, or to take any part in public processions, either private or official. The number of Raskolniks in Russia has been variously estimated as from five to fifteen millions. According to one writer in 1890 they were thus accounted: the Popovtzi, three millions; the Spiritual Christians, two millions; the Khlisti and Skoptzi seventy-five thousand; other sects of Bezpopovtzi, nine millions. (See RUSSIAN RELIGIONS.) Consult: Gardner, 'Faiths of the World'; Mouravieff, 'History of the Church of Russia' (London, 1842); and any encyclopædia of religious beliefs.

Raso'res, an obsolete, artificial group of birds, the "scratchers," represented by such forms as the fowls, partridges, grouse, pigeons, etc., which were long ago assigned to various natural orders and families.

Raspail, räs-pä-ē, **François Vincent,** French politician and scientist: b. Carpentras 29 Jan. 1794; d. Arcueil 7 Jan. 1878. He went in 1816 to Paris, where he took part in the July revolution of 1830, and later established a journal, 'Le Réformateur,' which in 1834 was suppressed by the government, while in 1835 its editor was condemned to a six months' imprisonment. On 24 Feb. 1848, at the head of a mob, he penetrated to the council chamber of the provisional government, which he compelled forthwith to proclaim the republic. He then founded 'L'Ami du Peuple,' later called 'Démocratie Pacifique,' in which he proclaimed Jacobin principles. On 15 May he was a leader of the invaders of the Palais Bourbon and the hall of the national assembly; for this he was condemned to six years in prison, but in 1855 the sentence was commuted to banishment. He lived in Brussels, but returned to France under the amnesty of 1859, was elected to the Corps Législatif in 1869, retired to private life during the Commune, and from 1876 was a member of the Chamber of Deputies. Among his works were: 'Annales des Sciences d'Observation' (1829–30); 'Recherches Chimiques et Physiques sur le Développement des Tissus Végétaux' (1827); 'Système Nouveau de Physiologie Végetale et de Botanique' (1836); 'Histoire Naturelle des Ammonites' (1842); 'Nouvelles Etudes Scientifiques et Philologiques' (1865); 'Réformes Sociales' (1872).

Raspberry, a general name for those shrubs of the genus *Rubus,* whose fruits separate from the receptacle upon attaining maturity. They are natives of the north temperate zone and are especially numerous in Europe and America. They are characterized by their perennial underground parts, usually biennial spiny stems which bear fruit the second season and then die. Several species are valued for ornamental purposes but the three following are the most important because of their edible fruits, for which the plants are widely cultivated especially in the United States and Canada. The European raspberry (*R. idæus*), which has been cultivated in Europe for several centuries, was among the earliest European fruits introduced into America, but it has not made an equal headway with the next species because it has a very extended period of ripening, and is more adapted to the amateur than to the commercial berry-grower. Its fruits, either red or yellow, are of the best quality, but the plants are considered somewhat tender in northern climates. The American red raspberry (*R. strigosus*) resembles the preceding species in habit and color of fruit, but is rather inferior in quality. This defect, however, is offset by its great productiveness, "cropping" qualities, hardiness and ready adaptability to many conditions. Having been in cultivation for only about half a century, its quick development to the rank of a leading small-fruit augurs still greater possibilities. The black raspberry or blackcap (*R. occidentalis*) is the most important species of its genus, since it is hardy, productive, adaptable to many soils and conditions, and its fruits, being firm, are useful for shipping considerable distances or for evaporating as well as for canning and eating fresh. It was introduced into cultivation in 1832, since when several hundred varieties have been offered for sale.

The red raspberries are propagated by means of suckers, or root-cuttings. The former may appear at any time throughout the growing season; the latter may be made by thrusting a spade deeply into the ground around well established plants and thus severing the roots, each piece of which will produce a new plant. With new or scarce varieties the plants are often dug up, the roots cut in small pieces and rooted under glass. In the field the plants are usually set not less than 5 by 5 feet or 4 by 6 feet apart. In the former case cultivation is given each way; in the latter only one way after the plants are two years old, the rows becoming more or less continuous from the growth of suckers The former is generally preferred.

The black raspberry does not produce suckers, except at the crown, but the tips of the canes bend over until their tips reach the ground and become covered and develop roots. Other buds near the end may develop short stems which also become rooted. These "tips" are severed for planting, sometimes in autumn but usually in spring, and are set somewhat farther apart than the red varieties. There is a hybrid group of raspberries which propagate by both tips and suckers or root cuttings, usually by the latter. They are supposed to be derived from the black and the American red species, but since they are common in the wild state and are fairly stable, they are often called *R. neglectus.* Several varieties have been widely cultivated. Their fruit ranges from purple, through reds to yellow.

Raspberries succeed best upon deep, moist, but well drained loamy soils; the blacks upon the heavier and the reds upon the lighter. The more retentive of moisture the soil is the better, since the fruit ripens at a time when water is often scarce. Hence the addition of humus is often desirable. It may be most easily obtained in the form of stable manure and green manures, such as clover grown at least one year before planting. The ground should be plowed as deeply as possible without turning up the subsoil, and after harrowing, the plants set. Clean cultivation both ways is usually practised until midsummer when a cover crop of crimson clover or some shallower rooting plant is sown to be turned under the following spring. Sometimes, however, other crops, such as potatoes, carrots, beets, etc., which are not tall, are grown between the rows for one or perhaps two years. Wood ashes, muriate of potash, superphosphates, and ground bone are favorite sources of potash and phosphoric acid. With adequate tillage during the summer, spring plowing may be avoided.

The pruning of the red varieties consists in pinching back the shoots during the first season, allowing only about five canes to grow in each stool in after years, avoiding the pinching of shoots unless the soil is very strong and the growth rampant, and cutting out the old canes as soon as they have fruited. The pruning of the blackcaps consists in pinching off the tips as soon as they have reached a height of about 21 inches to make the canes stocky and self-supporting, and shortening in the branches to about 18 inches the following spring. This latter amounts to thinning and should be carefully done.

For market the fruit should never be picked until after the dew has dried and should be shipped to market in small packages. Red raspberries are usually marketed in pint baskets. Black raspberries, specially for canning, are often gathered by jarring the ripe fruits into aprons with boxes attached, the fruit being passed through a fanning mill to blow away the leaves, etc. Generally, however, the picking is done by hand with red raspberries and with both kinds for the best markets.

Among the numerous insects which feed upon the raspberry are two species of cane-boring beetles, *Agrilus ruficollis* and *Oberea bimaculata;* wilting of the canes is usually the first indication of their presence, and cutting the injured ones is the only remedy recommended. The snowy tree-cricket (*Œcanthus niveus*, etc.) often lays its eggs in the stems, but is considered to be a beneficial insect otherwise, since its food consists largely of plant-lice. Several caterpillars and other foliage-chewing insects, such as the raspberry saw-fly (*Selandria rubi*), occasionally prove troublesome, and some of the stink-bugs reveal their presence by their disagreeable flavor when inadvertently eaten. General remedies have been recommended for these insects. (See Insecticide.) Several so-called plant diseases have been reported upon the raspberry. The orange rust has never been successfully combated except by digging out and burning plants attacked by it; and anthracnose has been held in check by spraying. (See Fungicide.)

Consult: Bailey, 'Cyclopedia of American Horticulture' (New York, 1900–2); Card, 'Bush-Fruits' (New York, 1899); Saunders, 'Insects Injurious to Fruits' (Philadelphia, 1889); Smith, 'Economic Entomology' (Philadelphia, 1896;) and numerous bulletins of Agricultural Experiment Stations.

M. G. Kains,
Crop Expert.

Raspberry Vinegar, a refreshing summer beverage and cooling drink for invalids, composed of raspberry juice, vinegar, and sugar.

Raspe, răs'pĕ, **Rudolph Eric**, German mineralogist and author: b. Hanover 1737; d. Muckross, Donegal, Ireland, 1794. In 1767 he was made professor in the Collegium Carolinum of Cassel, and curator of the Landgrave's museum of coins and antiquities. He published at this time papers on mineralogy and geology. In 1775 he went to England, where he was variously employed, generally as a mining expert. He published in 1785 'Baron Münchhausen's Narrative of his Marvelous Travels and Campaigns in Russia,' founded in part on the hunting stories of one Baron von Münchhausen, of Hanover. His work appears as chapters ii.–vi. of the later Münchhausen. See Münchhausen.

Rassam, răs-săm', **Hormuzd**, Turkish archæologist: b. Mosul, Asiatic Turkey, 1826; d. 16 Sept. 1910. Having formed the acquaintance of Layard (q.v.) in 1845 when the latter was beginning his explorations of Nineveh, Rassam accompanied him on his return to London and entered Oxford University, after which he went with Layard on several archæological expeditions. In 1851 Rassam, upon commission from the British Museum, collected for that institution a number of specimens of Assyrian art, particularly a series of sculptures representing the lion chase. In 1864 the British government despatched him on a mission to Abyssinia to secure from King Theodore the release of their consul, Mr. Cameron, and others held prisoners; but he was himself taken prisoner and held until the defeat of Theodore's army by Sir R. Napier in 1868. After 1876 he resumed his collections for the British Museum, the most notable of which were the bronze gates of Balawat, dating from Shalmanezer II., 858–824 B.C., and the "Abu-Habba tablet," from the temple of the sun-god in Sippar, recording the restoration of the temple by Nabu-apal-iddin. The British Museum was also enriched by his discovery of 5,000 tablets representing, probably, the library of an ancient Babylonish king. Rassam published a 'Narrative of the British Mission to Theodore' (1869); 'Asshur and the Land of Nimrod' (1897).

Rasse, răs, a small arboreal civet (*Viverricula malaccensis*), which is widely distributed in southeastern Asia and the Malayan islands; and long ago became naturalized in Madagascar. It is slender, agile in tree-climbing, has no erectile mane, and lives in holes in rocky and brushy districts. In confinement it is easily tamed and feeds on small animals, which it catches with cat-like dexterity. Hence it is often kept in houses in the East as a ratter, and also for the sake of its civet, which is artificially removed from the glands. It is a handsome little animal, spotted with blackish on a gray ground, and with a long black-ringed tail. Consult: Blanford, Jerdon, Tennent, and other authorities on Oriental zoology.

Rasselas, răs'ē-lăs, a philosophical romance by Dr. Samuel Johnson, published in 1759. Though little read at present it was in the 18th century the most popular of its author's works and was translated into many modern languages. It professes to relate the story of Rasselas, prince of Abyssinia, who with his brothers and sisters inhabits a Happy Valley secluded from the outside world.

Rassieur, răs'sē-ėr, **Leo**, American lawyer: b. Waden, Prussia, 19 April 1844. He was graduated at the Saint Louis Central High School in 1860. During the Civil War he volunteered as a private, and in 1865 was raised to the rank of major. In 1867 he was admitted to the Saint Louis bar and after holding office in the public schools was elected judge of the Probate Court (1899). In 1900 he was elected commander-in-chief of the Grand Army of the Republic.

Rastatt, räs'tät, or **Rastadt**, a town of Baden, Germany, on the river Murg, about 4 miles from the Rhine and about 15 miles southwest of Karlsruhe. It was formerly a fortress of the first rank, but in 1892 the fortifications were dismantled. The town has manufactures of lace, tobacco and cigars. Population nearly 16,000. Rastatt was the scene of two diplomatic congresses in the 18th century. The first congress of Rastatt met in 1713 to arrange terms of peace between the emperor and France, then still engaged in the war of the Spanish Succession. Peace was concluded 7 March 1714. In accordance with the terms of the treaty France gave up possession of the towns of Kehl, Freiburg and Breisach, and the electors of Cologne and Bavaria were reinstated in power. The terms of the treaty of Utrecht (q.v.) were ratified. The second congress of Rastatt met in 1797 for the purpose of terminating hostilities between France and the Empire. After negotiations had been prolonged for more than a year, war broke out again between France and the allies and the congress suspended its sessions (April 1799). As the French representatives, Roberjot, Bonnier and Debry left the city on the evening of 28 April, they were set upon by a company of hussars wearing the Austrian uniform and the first two were murdered. Many attempts have been made to fix the responsibility for the deed. Some have ascribed the crime to the Austrian government which was desirous of obtaining certain papers in the possession of the ambassadors; others maintain that the murderers were French émigrés, while others still assert that the act was instigated by Napoleon and other leaders of the war party in France for the purpose of exasperating the French people against Austria.

Rat, any of several large rodents of the mouse family (see MOUSE), especially two species of «house-rats» now habituated to civilization in all parts of the world. The black rat (*Musrattus*) is of light and slender build, about seven inches in length, usually of a bluish black color, but sometimes grayish, and has quite large thin ears. The brown rat (*M. decumanus*) or Norway rat, as it is often inappropriately styled, is much heavier and larger, with short rounded ears and a dull brown color. Both species are believed to be natives of China, but the black rat was abundant in Europe at least as early as the 13th century. The brown rat migrated from Western China, entering Russia in great numbers in 1727, and from there quickly spreading over Europe, which was fully occupied by it by the middle of the 18th century. By its greater fecundity and ferocity it quickly overcame the black rat, which it has now replaced in most parts. It infested ships and by this means has been carried to all parts of the world. Its wonderful capacity for increase (from 20 to 50 annually), its boldness, tough, elastic constitution and adaptable nature, make it everywhere dominant, and its omnivorous habits, voracity and destructiveness frequently lead it to become a source of great annoyance, loss and disease about human habitations. The ferocity of this species when brought to bay is well known; and when driven by hunger it is so ravenous that neglected babies have been known to be killed and eaten by them, and a few cases are recorded where even able-bodied men have suffered a like fate when attacked by hordes of rats. They are also agents in the spread of disease, particularly bubonic plague and trichinosis. Against their many faults may be set the solitary virtue that they serve a useful purpose as scavengers in the city sewers, etc. The albino and black and white pied rats sold for pets by bird dealers are derived from the black rat, which has a far milder disposition.

Rat-kangaroo. See KANGAROO.

Rat Portage, Canada, town and port of entry, Ontario, at the outlet of the Lake of the Woods, and on the Canadian Pacific Railway, 130 miles by rail east of Winnipeg. It is the chief town of the Rainy River District, and the distributing centre for the neighboring gold mines. The Winnipeg River with a fall of 16 feet from the lake, furnishes inexhaustible water power for sawmills, flour-mills, and other industrial establishments. The neighboring lake fisheries, especially of sturgeon, are valuable. Pop. about 6,000.

Rat-tail, one of the pelagic, cod-like fishes of the genus *Macrourus*, specifically *Macrourus bairdi* of the coast-waters of the eastern United States.

Ra'ta, any of several New Zealand trees of an Australasian group of the myrtle family which includes the local ironwoods. Foremost among them is *Metrosideros robusta*, a tall strong tree, of very hard wood, used by the natives for making their war-clubs, and by the colonists in cabinet-work and in ship-building. Another species (*M. florida*) is a huge climber. These trees have very showy flowers, usually red, and characterized by many tall erect stamens; and several species of the genus are cultivated as ornamental shrubs, and have been acclimatized in other parts of the world. One (*M. tormentosa*) is known in New Zealand as «fire-tree.»

Ratafia, răt-ạ-fē'ạ, a French cordial flavored with fruits; a general name for any liquor flavored with fruit syrups.

Rat'any, or **Rhatany.** See RATTANY.

Ra'tel, a South African badger (*Mellivora capensis*), rather larger than the common European or American badger, which lives in burrows in open districts. It differs from the Indian honey-badger (q.v.) mainly in the presence of a distinct white line along its sides, from the nose to the hocks, separating the black underparts from the blanket-like gray of the back.

Rath'bone Sisters, Order of. See ORDERS, RELIGIOUS.

Ratichius, rā-tĭk'ĭ-ŭs. See RATKE, WOLFGANG.

Ratifica'tion, in law, the confirmation, sanction or approval given by a person who has arrived at his majority to acts done by him during his minority. It has the effect of giving validity to such acts as would be otherwise voidable. «An act performed by one for another, is adopted as his own act when by him ratified. Ratifications are either express or implied. The former are made in express and direct terms of assent; the latter are such as the law permits for the acts of the principals.»

Ratio (from the Latin *ratio*, meaning reckoning, calculation), in mathematics, the measure of the relation which one quantity bears to another of the same kind; that is, the number of times that one quantity contains another regarded as a standard. This is found by dividing the one by the other. The quotient or ratio thus obtained is the proper measure of the relation of the two quantities. Some mathematicians define the ratio of one quantity to another as the quotient of the first quantity divided by the second, and others define it as the quotient of the second quantity divided by the first. The operation of finding a ratio is purely numerical, and the resulting ratio is consequently an abstract number. Ratios are known as *prime* or *ultimate*, according as the ratio of the variable quantities is receding from or approaching to the ratio of the constant quantities. Proportion is the relation of equality subsisting between two ratios. See MATHEMATICS; PROPORTION.

Ration, in the army and navy, is the allowance of provisions given to each officer, noncommissioned officer, soldier, and sailor. In the American army the ordinary ration is commonly supplemented by additional articles bought with what is known as «the company fund,» money derived from certain allowances made to the soldiers. The American troops and sailors are better fed than any in the world, whether in camp or war.

Rationalism, in its more general signification, denotes a tendency or attitude of thought, either on the part of an individual or an age, to demand that prevailing beliefs, customs, and institutions shall be subjected to critical examination, and be required to justify themselves before the court of reason. In its more specific sense, the term refers to the doctrines of a particular school of philosophical thinkers, which flourished mainly in France and Germany during the 17th and 18th centuries, and which regarded reason as the only source of certain knowledge, and the only test of truth.

In the general and more popular use of the term, rationalism is equivalent to a demand for a reasonable explanation in scientific terms. The rise of rationalism is thus in many respects identical with the development of the scientific spirit of inquiry. As such, it is opposed to mysticism and supernaturalism. Lecky, in his ‹History of the Rise and Influence of Rationalism in Europe,› explains the word as follows: «By the spirit of rationalism, I understand not any class of definite doctrines or criticisms, but rather a certain cast of thought, or bias of reasoning, which has during the last three centuries gained a marked ascendency in Europe. . . . At present, it will be sufficient to say, that it leads men on all occasions to subordinate dogmatic theology to the dictates of reason and of conscience, and, as a necessary consequence, greatly to restrict its influence upon life. It predisposes men, in history, to attribute all kinds of phenomena to natural rather than miraculous causes; in theology, to esteem succeeding systems the expressions of the wants and aspirations of that religious sentiment which is planted in all men; and, in ethics, to regard as duties only those which conscience reveals to be such.» Between the claims of revealed religion and the spirit of rationalism the conflict has been especially sharp and long-continued. This opposition shows itself even before the birth of Christianity in almost all of the older religions. In Greece, for example, where religion was only to a very slight extent embodied in dogmas, the philosophers were nevertheless frequently charged with atheism, or with perverting and destroying the national religion through their rationalistic teachings. With the establishment of the Christian Church, the doctrines of religion were explicitly declared to be above reason, and to rest upon a higher authority than human reason could afford. Nevertheless, from time to time there arose thinkers within the Church itself who strove to reduce the theological doctrines to a rationalistic basis, interpreting them in such a way as to minimize or destroy the supernaturalistic elements which they contained. Of these mediæval rationalists Abelard (q.v.), 1079–1142, is perhaps the most famous. It was not until the 18th century, however, that rationalism became strong enough and bold enough to make open war upon the prevailing theological beliefs and doctrines. This century was called the age of enlightenment, and in it the demand arose on all sides that everything should be explained in terms of the clear and distinct ideas of reason, that mysteries and superstitions should be abolished, that the authority of church and state should be limited and subordinated to the principles of reason and the interest of the individual members of society. The Deistic movement in England is especially noteworthy as maintaining the right of individual free thought in matters of religion, and as attacking the abuses and absurdities in the existing theological creeds. Lord Herbart of Cherbury and John Locke may be regarded as forerunners of English Deism (q.v.). The best known representatives of the movement are John Toland (1670–1729), Anthony Collins (1676–1729), Matthew Tindal (1657–1733), Thomas Chubb (1679–1747), and Thomas Morgan. The influence of this movement was felt throughout Europe. In Voltaire it found a spokesman of extraordinary literary power who had also the courage to carry its principles to its logical conclusions.

The spirit of rationalism, in so far as it represents the claims of free scientific inquiry, may be said to have already won its triumph. This triumph too, it must be admitted, was largely the result of the enthusiastic zeal of the apostles of the enlightenment. Nevertheless, the spirit of modern inquiry has been profoundly modified in many respects during the 19th century. In the first place, it has lost the narrowness and hardness that it necessarily exhibited so long as a large share of its strength was expended in negative criticism and in making war upon prevailing creeds and institutions. In addition, it has been transformed by the historical and evolutionary conceptions that have become dominant in every field of inquiry, leading men's thoughts, to problems of genesis and origin, and so to understand and sympathize with much that appeared absurd and unmeaning to the older rationalists. The 18th century rationalists regarded the world as static; they looked at each thing as it actually stood before them in their own day, and judged it by the unfailing standard that each individual was supposed to possess in the clear and distinct ideas of his own individual reason. The historical point of view has brought with it a broader conception of reason and what is rational: it has taught us that it is only in the light of its origin and function that a thing can properly be judged, and that, accordingly, there may be a truer rationality in historical creeds, beliefs, and institutions than in the self-confidence of the individual of clear and distinct ideas who ventures to criticize what he does not understand.

The philosophical doctrine known as rationalism owes its origin to Descartes (1596–1650), and has its home mainly in France and Germany, while empiricism (q.v.), the theory to which it was directly opposed, flourished mainly in England. The rationalistic school take mathematical demonstration as the perfect type of knowledge, and seek to model their procedure in all fields of inquiry on what they assumed to be its method. From the chaotic and contradictory material supplied by sense-perception they believed that real knowledge, science, could not be attained. Mathematics, however, reaches its results in independence of such a source. It begins with fundamental principles and conceptions which are self-evident, and proceeds by means of logical analysis and reasoning to show what further results are necessarily involved and implied in the starting-point. Now, the rationalistic thinkers maintain that what has been achieved in this particular science may be carried out universally by the application of the same method. That is, the true method of knowledge consists in first discovering by analysis the fundamental truths that lie at the basis of all thinking. These truths are not derived from experience, but, like the mathematical axioms and first principles, are native to the mind, innate ideas or *a priori* truths that are the starting-points for all demonstration and all science. When these are once discovered, it is the further task of philosophy to deduce by logical reasoning the further results that follow from them. In this way the rationalists supposed that it was possible to arrive at conclusions in philosophy that are as demonstrably certain as the propositions of geometry.

Besides Descartes, the chief representatives of rationalism are Spinoza (1632–77), who adopted the geometrical form of proof in his chief work, the 'Ethics'; Leibnitz (1646–1715), and Christian Wolff (1679–1754). The last mentioned philosopher, though the least original, exercised a great influence over the thought of Germany by his terminology, and by the systematic way in which he divided the field of philosophy into the so-called sciences of rational cosmology or physics, rational psychology, and rational theology. The first of these seeks to furnish demonstrative proof of the fundamental nature of the physical universe; for example, that it is limited in space, had a beginning in time, made up of indivisible parts, etc. Rational psychology sets out from the conception of the soul as a spiritual substance and attempts to prove that it necessarily follows as a result of this initial conception, that the soul is simple, indivisible, indestructible, and therefore immortal, and moreover, that it possesses certain faculties, such as those of representation, desire, as essential to its true nature. In like manner, rational theology dealt in the same *a priori* and deductive way with the various proofs for the existence and attributes of God. This was the form of rationalism in which Kant was educated, and it is against these so-called rationalistic sciences that he directs his attack in the dialectic of the 'Critique of Pure Reason.' The criticism of Kant was so penetrating and thorough-going that it annihilated at a blow the claims of rationalism. It did this by pointing out, in terms that could neither be mistaken nor denied, the falsity of the assumptions upon which this philosophical theory rests. Kant (q.v.) is thus the destroyer and finisher of rationalism.

Consult: Lecky, 'History of the Rise and Influence of Rationalism in Europe'; Stephen, 'History of English Thought in the Eighteenth Century'; White, 'The Warfare of Science and Religion'; Paine, 'Age of Reason'; Cairns, 'Unbelief in the Eighteenth Century' (1881); Descartes, 'Discourse on Method'; 'Meditations on the First Philosophy'; Zeller, 'Geschichte der deutschen Philosophie seit Leibnitz'; Windelband, 'History of Philosophy' (translated by J. H. Tufts); Kuno Fischer, 'Geschichte der neueren Philosophie,' Vol. III.; Kant, 'Critique of Pure Reason.' J. E. Creighton,

Professor of Philosophy, Cornell University.

Rationalists. See Religious Sects.

Ratisbon, răt'ĭs-bŏn (**Regensburg,** rā'gĕns-boorg), Bavaria, Germany, 82 miles by rail northeast of Munich, partakes of the artistic tendencies of the latter. Chief among its public buildings and institutions are the Gothic cathedral, library, art-gallery, seminaries and glass-staining factory. Trade, facilitated by its favorable position on the Danube, is considerable. Ratisbon suffered much from bombardments at various periods of its history, especially in 1809, when it was stormed by the French. Pop. about 47,000.

Ratitæ, rā-tī'tē, a group of birds broadly characterized as having a non-carinate sternum and little or no power of flight. The group originally was one of the two grand divisions of *Aves,* embracing all those whose sternum had no keel, as opposed to *Carinatæ* (q.v.); but this character alone will not define the *Ratitæ* as at present constituted by the researches of Gadow and accepted by ornithologists generally. Its place is as a subdivision of the *Neornithes* (q.v.) co-ordinate with the *Odontolcæ* (*hesperornis,* etc.) and the *Carinatæ;* and the sum of many anatomical peculiarities distinguishes the group, which consists of the ostriches, cassowaries, kiwis, moas, rocs (*Æpyornis*), and perhaps some of the fossil birds of Patagonia whose relationships are not yet perfectly clear. The conspicuous feature of all these is the rudimentary condition of the wings, so that the ratites are well designated flightless birds, the disappearance of the tail, and the great prominence of the functions and development of the legs and feet. These features are believed to be the result of changes, very long continued, from ancestors which possessed the power of flight and have lost it by disuse, and in adaptation to life upon plains and deserts. Consult: Evans, ‘Birds’ (1900); Newton, ‘Dictionary of Birds’ (1893–96); Stejneger, ‘Standard Natural History,’ Vol. IV. (1885).

Ratke, rät'kė, **Wolfgang** (better known by his Latinized name of RATICHIUS), German educator: b. Wilster, Holstein, 18 Oct. 1571; d. Erfurt 27 April 1635. He was trained in the Johanneum at Hamburg and the University of Rostock. Between 1603 and 1611 he lived in Holland and was the inaugurator of a new plan of school reform. The essence of his system was to discard the old memory and rote method of teaching children; to interest them, by presenting things to their observation, and afterwards, names — a reversal of the method then in vogue; to teach them their mother tongue first and thence proceed to foreign languages. At first he met with little success in propagating his views. In 1618, however, he settled at Köthen, Anhalt, and Prince Ludwig von Anhalt furnished him with the means of opening a school to be conducted according to his own ideas. Owing to certain faults of his own, as well as to the unsettled religious condition of Germany at that time he was obliged to, leave Köthen and settled at Magdeburg in 1721. Here he made a second failure and afterward led a somewhat wandering life. But his influence upon his contemporaries and posterity was much greater than would be supposed from the failure of his own attempts to put his plan in practice. Consult: Krause, ‘Wolfgang Ratke, im Licht seiner und seiner Zeitgenossen Briefe’ (1872); Schumann, ‘Die echte Methode W. Ratkes’ (1876).

Raton, ra-tōn', N. M., city, county-seat of Colfax County; on the Atchison, Topeka & Santa Fé railroad; about 130 miles northeast of Santa Fé and eight miles south of the northern boundary of the Territory. In the vicinity are extensive coal fields. It is the commercial and industrial centre of a large region devoted chiefly to farming and stock raising. It has railroad shops, stock yards, grain elevators, wholesale houses, and brick and lumber yards. Pop. (1910) 4,539.

Rattan', a product of *Calamus rotang*, a scandent palm of Ceylon, but also found in India and Burma. While this species furnishes the best commercial rattan, there are nearly 200 species in this genus, inhabiting tropical and subtropical Asia, Africa, and Australia. The most important species other than the above are *C. rudentum*, *C. pachystemonus*, and *C. radiatus*, abounding throughout the damp forests of Ceylon up to 3,500 feet elevation. *C. rotang*, and the first two species named above are manufactured into a great variety of useful articles such as baskets, chairs, the hoods of carts, and when split into strips, can be twisted into cordage of great strength. *C. rotang* is often used in eastern countries for rope bridges, or, used entire, is stretched across rivers as the supports of suspension bridges; and is also employed for the manufacture of Malacca canes. In China rattan is a favorite material for cordage, and the material also enters into the manufacture of umbrella handles and ribs, and as a substitute for whalebone. The cane is used for saddlery and harness and for wickerwork helmets, said to be sword-proof. The two smaller species (*C. pachystemonus* and *C. radiatus*) are largely employed in the manufacture of baskets for the Ceylon tea gardens, used in picking the tea leaves. *C. radiatus* supplies the material for chair bottoms, being split into thin strips. In fact the many uses of rattan in eastern countries are almost nameless. In the United States rattan is largely used for manufacturing chairs and other furniture, for chair-seating, baby-carriage bodies, baskets, floor mattings, brooms, corset-stays, whips, and many other uses of minor importance. The «reed» used in raffia fancy-basket manufacture, a recent fad in this country, is the split inner portion of rattan dressed in cylindrical form like the true reeds. See also FIBRE.

CHAS. RICHARDS DODGE,
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Rat'tany, or **Rhatany**, a coarse plant of the genus *Krameria* and order *Polygalæ*, native to the Andean table-lands. The roots have medicinal value as an astringent, and serve, especially in Portugal, to color wines ruby-red. This property is due to the presence of ratanhia tannic-acid. The root-bark also contains an almost insoluble free red substance called ratanhia-red.

Rattazzi, rät-tät'sē, **Marie Studolmine de Solms**, French novelist: b. Waterford, Ireland, 1833; d. Paris February 1902. She was the daughter of Sir Thomas Wyse, British ambassador to Greece, and Letitia, eldest daughter of Lucien Bonaparte. She was married to Urbano Rattazzi (q.v.) in 1863, and to M. de Rute in 1877. Twice, in 1852 and 1864, she was exiled. She wrote much in prose and verse, and was a prominent figure in the politics and society of the Second Empire salons. Among her works were: ‘Les Mariages d'une Creole’ (1864); ‘Si j'etais Reine’ (1868); ‘L'Aventurier des Colonies’ (1885), a drama; and the volume of tales, ‘Enigme sans Clef’ (1894).

Rattazzi, Urbano, Italian statesman: b. Alessandria 29 June 1810; d. Frosinone 5 June 1873. He studied law at Turin and, after practising with marked success at the capital and at Casale, was elected a member of the Sardinian parliament from his native town in 1848. He allied himself with the liberal party and attained such speedy recognition that in August he was made minister of public instruction. He left office after a few days, but in December of the same year assumed the portfolio of the interior under Gioberti, exchanging it later for that of justice. On the fall of the Gioberti ministry, Rattazzi was entrusted with the formation of a new cabinet (February 1849) but the disaster of Novara in the following month robbed him of power. From democrat he now turned moderate liberal and formed the party of the left centre whose coalition with the right centre under Cavour (q.v.), the so-called «connubio,» brought about the fall of the d'Azeglio cabinet in November 1852 and the organization of a new ministry by Cavour. Rattazzi gave up the presidency of the Chamber to become in 1853 minister of justice, and later, of the interior, and in the second capacity precipitated a bitter struggle with the clerical party by the introduction of a law providing for the partial secularization of church property and restricting the influence of the religious associations. He left the cabinet in 1858 but in

July of the following year, after Villafranca, succeeded Cavour as head of the cabinet, only to give place to his predecessor within six months. He opposed the cession of Savoy and Nice to France, became president of the lower chamber in the first Italian parliament and in March 1862 succeeded Ricosoli in the government, retaining for himself the portfolios of foreign affairs and of the interior. His course in checking the patriotic agitation against the Austrians in Lombardy and the papal rule in Rome, brought him great unpopularity and in December 1862 he retired from office. Once more he succeeded Ricosoli, as premier, in 1867, but again had to yield to the storm of popular anger aroused by his hostile attitude toward Garibaldi (q.v.) and he resigned in October of the same year.

Rat'tigan, Sir **William Henry,** English jurist: b. Delhi, British India, 4 Sept. 1842. He was educated at King's College, London; admitted to the bar in 1873; served four times as judge of the chief court of Punjab; was additional member of the supreme legislative council of India 1892–3, and member of the Punjab legislative council 1898–9. In 1895 he was knighted and since 1901 he has been member of Parliament for northeast Lanarks. He has published 'De Jure Personarum' (1873); 'The Science of Jurisprudence' (3d ed. 1892); 'Private International Law' (1895); etc.

Rattlesnake, a distinctively American group of poisonous serpents characterized by a peculiar horny rattle appended to the tail. They belong to the suborder *Solenoglypha,* all the members of which are poisonous and have the fang-bearing maxillary bones erectile. To this suborder belong the Old World families of *Viperidæ* (vipers) and the *Crotalidæ,* or pit-vipers, which inhabit both hemispheres. The latter have the maxillary bone deeply excavated to lodge a sensory pit of unknown function opening on the face between the eye and nostril. There are two subfamilies, the *Lachesinæ,* which have no caudal rattle, and the *Crotalinæ,* or rattlesnakes. The former includes the copperhead, water moccasin and fer-de-lance (qq.v.), the banana snake, whose presence in bunches of this fruit so often causes consternation on fruit ships and in storage houses, and numerous others of tropical America, India, and the Malay Islands.

The *Crotalinæ,* or rattlesnakes, represent the highest type of serpent development and specialization. The caudal rattle, from which they take their name, consists of a series of dry horny epidermal rings so loosely fitted that any movement causes them to knock together with a sharp rustling rattle. They are formed in the following manner: Several of the terminal vertebræ of the tail are coalesced to form a dilated vertically enlarged plate. This is covered with a thick vascular skin so cut by an annular constriction as to form a larger anterior, and a smaller posterior knob, which together may be considered to be a mold on which the joints of the rattle are formed. The epidermis covering this region is especially thick, and in the young snake forms a button and ring, which are the only indications of the rattle. When the snake sloughs, the horny covering is loosened here as elsewhere and a new layer is formed beneath it; but instead of being cast off with the rest of the epidermis, the open end of the old horny ring fits over and by its elasticity clasps the new knob at the end of the tail, and by this means remains attached. With each subsequent molt a new ring and button are added, the latter serving to hold its predecessor in the series, and which continue to increase in size with the growth of the snake and its caudal knob. As well-fed snakes may slough 3 or 4 times a year, and as the rings sooner or later become worn out and detached, it is evident that the popular belief that the number of joints in the rattle indicate the years of the snake's age is unfounded. Rattles of more than 12 joints are rare, but one having 21 is known. When the snakes are irritated or angry, the end of the tail is more or less elevated and vibrated rapidly, producing a sound audible at a distance of 30 or 40 paces. Many snakes, both venomous and innocuous, have this habit of vibrating the tip of the tail when angry and many have a hard horny spur or cap at its end, but no others retain this through a succession of molts. Many fantastic theories have been proposed in explanation of the utility of the rattle, but it is probably little more than a recognition character, which helps to bring the sexes together and to segregate the species. However, it is probable that its sounding formerly saved the lives of many rattlesnakes by warning large animals acquainted with their deadly powers from the vicinity, but since the advent of the white man it has had a precisely opposite result.

Poison.— The venom apparatus of the rattlesnakes is the most complete and effective contrivance imaginable for injecting the poisonous fluid into the circulation of a victim. The maxillary bones are very short and are freely movable on an articulation with the prefontals. Upon them are attached the venom fangs at such an angle that with the movements of the maxillary they may be depressed in a fold of mucous membrane or erected vertically in the very front of the mouth in a most effective position for striking. The tooth substance of the fang is folded into a tubular form, with an opening at the base to receive the end of the venom duct and another near the front face of the needle-pointed tip. Behind the functional fang, which may be nearly an inch long in large snakes, is a succession of smaller reserve fangs, which become functional in order as their predecessors are lost. The venom gland, which corresponds to the parotid salivary gland of other animals, is situated on the cheek and has a duct running to a sinus at the base of the fang. All of the muscles and other parts are so arranged that the same movements that open the mouth and press the horizontal pterygoid bones forward to erect the maxillaries with their fangs, also compress the poison gland and squeeze out its secretion. Cope describes the biting movement as threefold. "First, there is the spring of the body, which never exceeds two thirds of its length; second, the bite proper, caused by the seizing of the jaws; and, third, the clutch with the fangs themselves, which are moved freely backward and forward." This movement of the fangs may be easily seen by holding a rattlesnake so that it cannot strike, when drops of the pale yellow venom may be seen to fall from their tips and are sometimes blown from the mouth by forcible expirations. The active principles of the venom are several soluble proteids, one of which has a disorganizing effect on tissues with which it comes in contact and another is a powerful heart and respiratory depressor. The immediate effect of a bite is severe burning pain followed in 10 or 15 minutes by prostration, with dizziness, vomiting, and cold sweats; the heart action is very feeble and the pupil dilated. This condition gives way in from 12 to 15 hours to one of fever and difficult respiration, while the part affected becomes greatly swollen and the neighborhood of the wound suppurates. Death may occur in either of these stages or as a result of secondary gangrene. Treatment to be effective must be prompt and thorough. A ligature should be applied above the wound and the latter enlarged with a clean knife until the blood flows freely. Permanganate of potash, bleaching powder, chromic acid, silver nitrate or other substances, which render the active albumens insoluble should be applied to the wound. Small and frequent doses of whiskey, strychnine or ammonia should be administered as a stimulant, but an excess of alcohol may increase the depression. Every effort should be made to press or draw the poison from the wound before the ligature is removed, but sucking with the mouth is always dangerous.

Species of Rattlesnake.— Of rattlesnakes three species of *Sistrurus* and 16 of *Crotalus* have been described, three of which are South and Central and the rest North American. None occur in the West Indies. The species of *Sistrurus* are small snakes with the snout and frontal region of the head covered with large plates. The ground rattlesnake or massasauga (*S. catenatus*) is found on low prairie lands from Ohio and Minnesota southward, but is now rare or exterminated in all settled parts. It reaches a length of three feet and is not considered especially dangerous. About six young are born alive in September; and this is one of the snakes for which it is pretty clearly established that the newly hatched young seek refuge from danger in the mouth and gullet of the mother. A related species (*S. miliarius*) is found in the Southern States.

In the genus *Crotalus* the entire top of the head is covered with small scales. The common or banded rattlesnake (*C. horridus*) was formerly abundant throughout the entire eastern United States, and it is the only species found in the New England and Middle States, but has been largely exterminated by the white man and his companion, the hog. The latter in roaming the woods in search of mast, etc., never fails to kill and devour the rattlesnake whenever possible. It is commonly believed that the hog is immune to snake-bites, but the truth is that the poison is dissipated in the thick skin and layer of subcutaneous fat, and never reaches the vascular tissues beneath. This rattlesnake prefers sparsely wooded rocky ridges with sunny exposures and in such localities is still common in the mountains from Pennsylvania to Tennessee. It is a sluggish and generally peaceful creature and seldom bites, except to secure food, unless it be trod upon or startled. When about to strike it coils with the head in the middle and elevated and the rattle sounding, delivers a lightning-like blow and immediately re-coils or slowly retreats. It seldom attacks without provocation, or follows a foe. All kinds of small mammals, especially mice, and occasionally birds are its food, and it drinks water freely. The cold months of the year are passed in hibernation and frequently large numbers of these snakes congregate in caves or beneath rocks for this purpose. Mating takes place in the early summer and about September from six to nine young about nine inches long are born alive. A length of five feet is sometimes attained, but ordinary examples seldom exceed four. Among the natural enemies of the rattlesnake are the king-snake and blacksnake, birds of prey and herons. The diamond or water rattlesnake (*C. adamanteus*) reaches a length of upward of eight feet and a circumference of fifteen inches, and is not only the largest of the rattlesnakes, but the bulkiest of all poisonous snakes, being exceeded in length only by the slender snake-eating cobra. It inhabits the Southern States and is particularly abundant on the Florida Keys. Except that it prefers the vicinity of water, in which it swims freely, its habits are much like those of the common species. Because of its great size, and the large amount of venom which it secretes, this is an extremely dangerous reptile; it is also sometimes inclined to be aggressive. The prairie rattlesnake (*C. confluentus*) inhabits most parts of the western plains and deserts, and is exceedingly abundant in unsettled regions. This is the species which plays a part in the famous triple alliance of prairie-dog, owl and rattlesnake, which, although popularly supposed to be a most amicable arrangement, is at best a state of armed neutrality and frequently of open warfare. The owls and snakes seek the burrows of the marmot as safe retreats and nesting sites, as well as for the purpose of feeding on the young marmots, while the latter frequently show their resentment of the intrusion in a variety of ways. A very distinct species is the horned rattlesnake (*C. cerastes*), in which the superciliary scales are produced into a pair of prominent horns surmounting the eyes. It is abundant in the desert region of the Southwest, especially about Death Valley, and is known in Arizona as the sidewinder from its peculiar habit of retreating sidewise from an intruder. Numerous other species inhabit these same hot dry regions.

Rattlesnakes possess a certain economic importance. As checks on the increase of the native mice and rats, they, in common with many other snakes, perform an important service. Their venomous qualities are such a menace to man and beast as to render their destruction both expedient and certain in all thickly settled districts. By the Indians and by the whites in certain parts of the South their flesh is relished; an oil or salve, supposed by the credulous to possess peculiar medicinal virtues, is claimed to be manufactured from their livers and other fatty parts; and the use of the skin for making purses, belts and other small articles is well known. Certain tribes of Indians employ these snakes in their ceremonials and others formerly poisoned the tips of their war-arrows with rattlesnake venom, while the rattles always figured among the charms of the medicine-man.

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J. Percy Moore,
University of Pennsylvania.

Rattlesnake Root. See Polygala.

Rattlewing, a duck. See Golden-eye.

Rau, row, **Charles,** American archæologist: b. Vervien, Belgium, 1826; d. Philadelphia, Pa., 25 July 1887. He was educated at the University of Heidelberg and came to this country in 1848, where he engaged in teaching. From 1875 until his death he was curator in the National Museum at Washington, D. C., and devoted himself to the study of American archæology, on which he became a recognized authority. He wrote: 'Early Man in Europe' (1876); 'The Palenque Table in the United States National Museum' (1879); 'Articles on Anthropological Subjects, 1853–1877' (1882).

Rauch, rowH, **Christian Daniel,** German sculptor: b. Arolsen, Western Germany, 2 Jan. 1777; d. Dresden 3 Dec. 1857. In Arolsen he received his first instruction in art from the sculptor Valentin, under whom he executed ornamental work chiefly. Going to Cassel he became a pupil of Kuhl, the sculptor, and was appointed groom of the chamber in the king's household at Berlin. This gave him an opportunity of advancing in his art, and in 1802 he exhibited his 'Sleeping Endymion' and modeled a bust of Queen Louise (1804), which he subsequently executed in marble at Rome. In this city he found a patron in Humboldt, as well as in the first sculptors of the time, Canova and Thorwaldsen. Among his Roman work of early days must be mentioned the busts of the poet Werner, and the life-sized busts of Queen Louise, Count Wenyerski, and the painter Raphael Mengs, executed under the commission of Ludwig of Bavaria. His colossal bronze statues of Blücher are 13 feet in height, and he also executed the greater part of the 12 statues in iron which compose the national monument at Kreuzberg, near Berlin.. One of his finest works is the group 'Faith, Hope and Charity,' which he presented to his native town Arolsen, while his crowning work as a portrait and historic sculptor is his statue of Frederick the Great at Berlin (1851). He was one of the first, if not the very first, among German sculptors of his time, combining in his work the pure lines of transcendent dignity and grace with genuine portraiture of the individual. There is a poetic freedom in his conception of ideal subjects which does not yet overstep the limits of truth and fidelity to nature, and he may be safely styled the founder of the great Berlin school of sculpture. Consult: Eggers, 'Chr. D. Rauch' (1873); 'Rauch und Goethe, urkundliche Mitteilungen' (1880).

Rauhes Haus, row'ĕs hows (corrupted from "Ruges Haus"), an educational and benevolent institution at Horn, near Hamburg, founded in 1833 by J. H. Wichern, who long remained at its head. It is connected with the German Home Mission, and besides forming a refuge for neglected children, receives boarding pupils from the higher classes, and serves as a training school for those wishing to become teachers, superintendents, or assistants in hospitals, reformatories, houses of correction, and the like. It is supported by voluntary contributions, the profits arising from the productive enterprises carried on in connection with it, and the fees of the richer pupils. In 1903, about 90 poor children were receiving instruction within its walls. They live in "families" of from 12 to 15, each "family" being under the care of one of the adult members of the mission training school. The educational department is in the hands of assistants, who also take part in the instruction of the institution, in order to prepare themselves for the work of the Home Mission in other localities. This indeed has become one of the most important features of the work carried on by the Rauhes Haus, and its graduates are found in every field of charitable work in Germany. The whole staff of assistants, consisting of young men of 20 to 29 years of age, are formed into a kind of society (*Brüderschaft*). Since 1844 the institution has carried on a printing and book-binding business. Its organ is the 'Fliegende Blätter.'

Raum, rowm, **Green Berry,** American lawyer: b. Golconda, Ill., 3 Dec. 1829. He was admitted to the bar in 1853; removed to Kansas and served in the Union army in the Civil War, rising to the rank of brigadier-general of volunteers. He sat in Congress 1866–9; was commissioner of internal revenue 1876–83, and United States commissioner of pensions 1889–93. He has published: 'The Existing Conflict' (1884); 'History of Illinois Republicanism' (1900).

Raumer, row'mĕr, **Friedrich Ludwig Georg von,** German historian: b. Wörlitz, near Dessau, Anhalt, 14 May 1781; d. Berlin, Germany, 14 June 1873. He studied law at Halle and Göttingen, and entered the Prussian state service in 1801. In 1811 he accepted the chair of political economy at Breslau, and in 1819 was called to Berlin. He was for some time secretary of the Berlin Academy, and at different times between 1816–55 traveled extensively through Europe and the United States. In 1848 he was elected to the Parliament of Frankfort, and was sent to Paris as ambassador. He was a member of the House of Lords of Prussia from 1851 until his death. He founded and edited in 1830–67 'Historisches Taschenbuch.' The first scientific historian to popularize history in German, Von Raumer wrote: 'Geschichte der Hohenstaufen und ihrer Zeit' (1823–5); 'Geschichte Europas seit dem Ende des 15. Jahrhunderts' (1832–50); 'Die Vereinigten Staaten von Nordamerika' (1845); 'Handbuch zur Geschichte der Litteratur' (1864–6).

Raumer, Karl Georg von, German geologist and educator, brother of the preceding: b. Wörlitz, Germany, 9 April 1783; d. Erlangen, Germany, 2 June 1865. He was educated in Göttingen, Halle, and Freiberg, and in 1811 became professor of mineralogy at Breslau, was called to Halle in 1819, and in 1827 settled permanently as professor of natural history at Erlangen. He published: 'Geognostische Fragmente' (1811); 'Lehrbuch der allgemeinen Geographie' (1832); 'Geschichte der Pädagogik' (1843–51); etc. Consult his autobiography (1866).

Raumer, Rudolph von, German philologist, son of Karl Georg von Raumer: b. Breslau, Germany, 14 April 1815; d. Erlangen, Germany, August 1876. He was privat-docent at Erlangen in 1840–6; professor there in 1846–76, and published: 'Untersuchungen über die Urverwandtschaft der semitischen und indo-europäischen Sprachen' (1868 et seq.).

Raupach, row'päʜ, **Ernst Benjamin Salomo,** German dramatic poet: b. Straupitz, near Liegnitz, 21 May 1784; d. Berlin 18 March 1852. He studied at Halle, afterward went as a tutor to Russia, and in 1816 obtained a chair in the philosophical faculty of the University of Saint Petersburg; but quitted the country in 1822, and after various changes finally settled, in 1824, in Berlin, where he employed himself chiefly in writing for the stage. His dramatic works have been collected and published in two divisions, the one containing his comic pieces, under the name of 'Dramatische Werke komischer Gattung' (1828–35); and the other, 'Dramatische Werke ernster Gattung' (1830–43). In his earlier works he was an imitator of Schiller, and some of the tragedies belonging to this period, such as 'Die Erdennacht,' show much real power. His popular success was considerable; but his dramas became more and more trivial in content. They display, however, considerable knowledge of stage effect, great creative power, and a wealth of verbal wit. A life of the dramatist was published by Pauline Raupach (1853).

Raupp, rowp, **Karl,** German painter: b. Darmstadt 1837. He began as a landscape painter, and between 1856 and 1858 studied genre under J. Becker at Frankfort, and under Karl Piloty at Munich Academy from 1860 to 1865. Subsequently he opened a studio, taking private pupils in painting, and in 1868 his reputation as a teacher gained for him the position of professor in the art school at Nuremberg, which he held up to 1879, when he was appointed professor in the Academy at Munich. Among his works may be mentioned: 'A Boating Party on the Chiem See'; 'Home Before a Storm'; 'A Calm'; 'Ave Maria'; 'Sport and Work'; 'Starting Home from the Monastery School.'

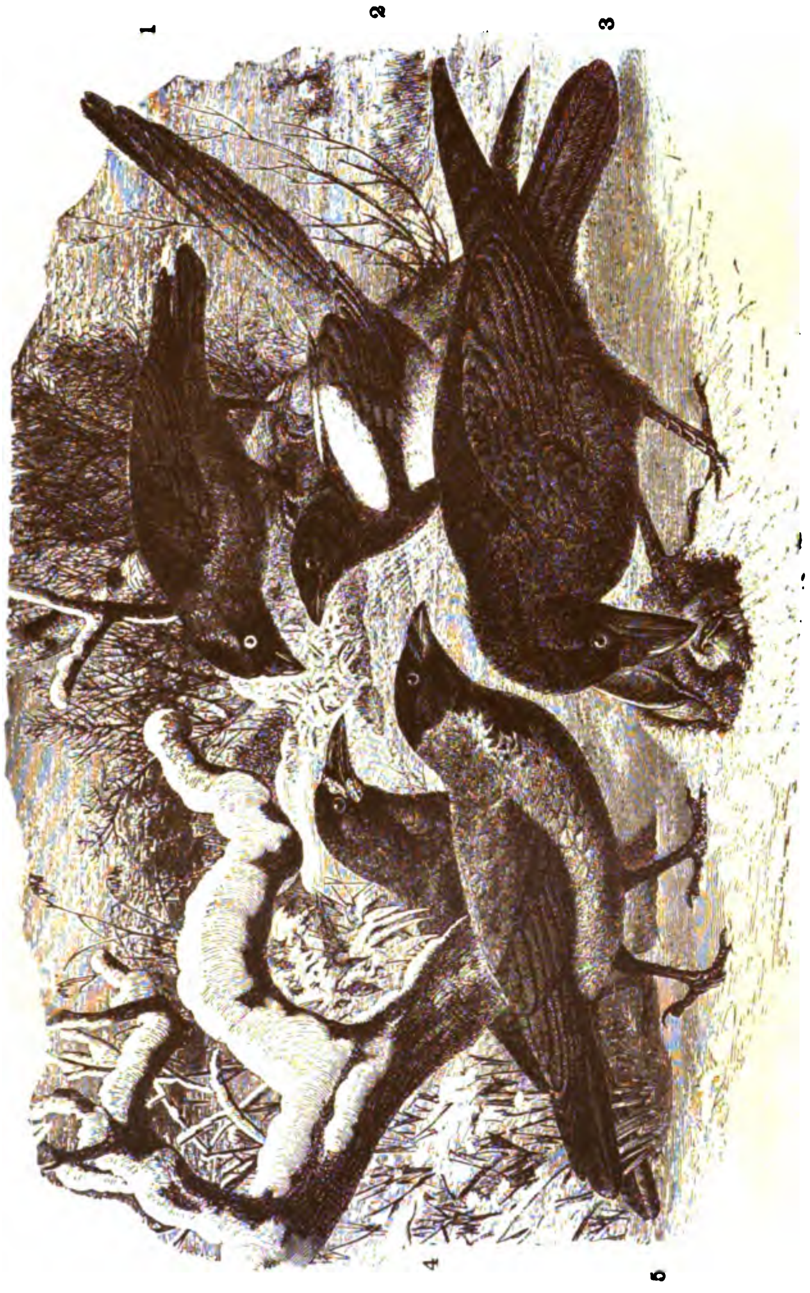
Ravaillac, François, fräṅ-swä rä-vä-yäk, French assassin: b. Touvres, near Angoulême, 1578; d. Paris 27 May 1610. He was successively valet to an attorney, in which situation he learned to read and write; attorney's clerk, and schoolmaster. He could never succeed in any undertaking, however, and was thrown into Angoulême prison for debt, where he remained for a considerable time. At last he was released, and turned out into the world a beggar. He entered the order of the Feuillants, but was expelled shortly afterward as a visionary. His naturally gloomy disposition degenerated into fanaticism when he began to meddle in the religious controversies that distracted France. He came to consider King Henry IV. as the arch enemy of the Church, to destroy whom would be a meritorious work. On 14 May 1610, while the king's carriage was standing in the street, Ravaillac approached and stabbed him. He was condemned to be torn to pieces by four horses, and this he underwent, previously declaring that he had no accomplices to his crime.

Ravana, rä'vä-nä, in Hindu mythology the Rakshasa, who, at the time of Rama, ruled over Lanka or Ceylon, and, having carried off Sita, the wife of Rama, to his palace, was ultimately conquered and slain by the latter. He is described as a giant with 10 faces, who in consequence of austerities and devotion, had obtained from Siva a promise which bestowed on him immunity from the power of demons and gods. Vishnu became incarnate as Rama, and hence killed the demon giant, whose kingdom had been invaded by men with the assistance of monkeys, against whom Ravana, in scorn, had omitted to make any stipulations in his compact with Siva.

Raven, a typical species (*Corvus corax*) of the crow family (*Corvidæ*), of which, as indeed of all passerine birds, it is the largest representative. The size is quite variable, but is generally about two feet in length and four feet in expanse. Plumage, bill, and feet are all black, the former with rich purple and violet lustres, but duller in the young and females, which are likewise smaller. The raven inhabits Europe, a large part of Asia, and North America from the Arctic Ocean to Guatemala. In North America two sub-specific forms are found, *C. corax sinuatus* being the western, and *C. corax principalis* the larger northern and eastern race. The former is generally abundant in the Rocky Mountain region; the latter has been largely exterminated in the eastern United States, but is still found in many inaccessible waste and mountain districts and reaches a very large size in Labrador and northward. Northwardly the raven is migratory, but may withstand the cold of the severest winters, as it often does in Canada and about the Great Lakes.

It is most abundant in rocky districts, near the banks of lakes and rivers, and is generally seen alone or in pairs, but sometimes in small flocks after the breeding season; the flight is rapid, elevated, and protracted, often sailing for hours at a time at a great height; on the ground the gait is grave and dignified, with frequent opening of the wings. It is truly omnivorous, but by preference carnivorous, eating small animals of all kinds, eggs, and young birds, carrion, dead fish, mollusks, crustaceans, insects, nuts, and berries. The European raven is reputed to destroy young rabbits and even lambs. It disgorges indigestible substances, as bones, hair, and feathers, like birds of prey. It is very wary and cunning, and is rarely caught in traps or shot by the hunter, but it often falls a victim to the poisoned baits set by the trappers for the fur-bearing animals. It breeds, according to latitude, between January and June, making a rude nest on inaccessible cliffs or tall trees, repairing the same for years in succession; the eggs are four to eight, two inches long, light greenish blue with numerous light purple and yellowish brown blotches, especially at the larger end; incubation lasts about three weeks, and the young remain in the nest several weeks before they are able to fly, fed at first on the half digested food disgorged by the parents; only one brood is raised in a year, and this is bravely and successfully defended against the largest birds of prey. The raven is easily domesticated by kindness, and becomes much attached to its master, following him like a dog. Like others of the family it can be taught to imitate the human voice and to pronounce a few words with great distinctness; but the natural note is a deep, hoarse croak. The white-necked raven (*C. cryptoleucus*) of Mexico and the south-

RAVEN TRIBE.



1. Jackdaw. 2. Magpie. 3. Raven. 4. Rook. 5. Gray Crow.

western United States has the concealed bases of the neck feathers pure white. Several other raven-like species inhabit Africa. The large size, black color, mournful croak, charnel-house habits, together with the boldness, sagacity and wariness of the raven have combined to make it an object of superstitious fear and hate. As a bird of ill omen it was watched by the ancient augurs with close attention; it holds a prominent place in mythology and folklore, and receives frequent notice in literature.

Ravenel', Harriott Horry, American biographer: b. Charleston, S. C., 12 Aug. 1832. She was married in 1851 to St. Julien Ravenel M.D. She is a prominent member of the Society of Colonial Dames of America. She has published 'Ashurst' (1870); 'Life of Eliza Pinckney' (1896); 'Life and Times of William Lowndes of South Carolina' (1901).

Ravenel, Henry William, American botanist: b. Berkeley, S. C., 19 May 1814; d. Aiken, S. C., 17 July 1887. He was graduated from South Carolina College in 1832, made a life study of the fungi and cryptogams and became one of the best botanical authorities in the United States. He made a critical study of the phænogams of South Carolina, was botanist of the government commission to Texas in 1869, and was agricultural editor of the 'Weekly News and Courier.' The genus *Ravenelia* of the *Uredineæ* is named in his honor. He wrote: 'Fungi Caroliniani Exsiccati' (1853–60); and with M. C. Cooke 'Fungi Americani Exsiccati' (1878–82).

Ravenna, rạ-vĕn'ạ (It. rä-vĕn'nä), **Italy,** (1) capital of the province of the same name, 45 miles east of Bologna. Though standing in a low marshy plain it was once a flourishing city, and the seat of the exarchate of Ravenna of the Western Roman Empire, close to the Adriatic Sea, but now five miles distant. Laces, wines, and agricultural implements form the chief articles of trade. The salient points of interest are found in its ancient churches, museums, tombs, and historical landmarks, among which may be mentioned the palace and tomb of Theodoric, the temple containing Dante's tomb, and Lord Byron's house. Pop. about 65,000. (2) The province has an area of 715 square miles.

Ravenna, rạ-vĕn'ạ, **Ohio,** village, county-seat of Portage County; on the Baltimore & Ohio, the Erie, and the Pennsylvania R.R.'s; about 28 miles southeast of Cleveland. It is in an agricultural region, and has extensive industrial interests. The chief manufacturing establishments are foundries, machine shops, furniture factories, brick and tile works, electrical supply works, flour and lumber mills, iron and boiler works and cigar factories. It has a large trade in farm, clay, and iron products, and in livestock. In the vicinity are a number of small and beautiful lakes, which have been made popular outing places. Pop. (1890) 3,417; (1900) 4,003; (1910) 5,310.

Ravenna Grass. See GRASSES IN THE UNITED STATES.

Ravenscroft, rā'vĕnz-krŏft, **Edward,** English dramatist, who flourished between 1671 and 1700. He was exceedingly popular in his day, though his work was never original, consisting of translations from older plays, and at times he even borrowed from his own previous works. His first play was 'Mamamouchi' (1671), taken from Molière's 'The Gentleman Citizen.' His plays include: 'The Wrangling Lovers' (1676), after Corneille; 'Scaramouch, a Philosopher' (1677); 'Dame Dobson' (1683); 'The Canterbury Guests' (1695); 'The Italian Husband' (1698); etc.

Ravenscroft, Thomas, English composer: b. near London 1592; d. London 1635. He was educated for his profession in St. Paul's choir, and at 15 received the degree of Bachelor of Music from Cambridge. In 1611 he published a collection of 23 part-songs, under the title 'Melismata,' which are of remarkable beauty. In 1614 appeared his 'Brief Discourses,' another collection of 20 part-songs to which he has prefixed an essay on the ancient musical modes. In 1621 he published his 'Whole Book of Psalms,' containing a chant for each psalm, many new, and all harmonized in four parts by Tallis, John Milton (the poet's father), Ravenscroft himself, and other musicians.

Ravenshoe, rā'vĕnz-hō, a novel by Henry Kingsley, published in 1862. The House of Ravenshoe, in Stonington, Ireland, is the scene of this novel; and the principal actors are the members of the noble family of Ravenshoe. The plot is remarkable for its complexity, and the book contains many bits of piquant humor.

Ravenstein, rä'vĕn-stīn, **Ernst George,** Anglo-German geographer and statistician: b. Frankfort-on-the-Main 30 Dec. 1834. He was educated privately and in 1852 removed to London. In 1855–75 he was engaged in the topographical (now intelligence) department of the war office, was a member of the council of the Royal Statistical Society in 1877–92 and of the Royal Geological Society in 1894–6. He founded the German Gymnastic Society in 1861 and served as its president for 10 years and in 1882–3 he was professor of geography at Bedford College. He has published: 'The Russians on the Amur' (1861); 'Geographie und Statistik des Britischen Reiches' (1863); 'Map, Equatorial Africa' (1884); 'The Strange Adventures of Andrew Battell' (1901); etc.

Ravesteijn, rä'vĕ-stīn, **Jan van,** Dutch painter: b. The Hague about 1572; d. there 21 June 1657. He was elected into the old Painters' Guild of Saint Luke at The Hague in 1598; the new guild was organized in 1655, and a Jan van Ravesteijn is enrolled among its members, but this may have been his son who bore the same name. He probably began his artistic studies under Frans Hals. His special department was portrait, in which he took rank among the first painters of Holland. Two large pictures of his with grouped portraits are to be seen in the Hall of the Company of Archers at The Hague; and in that city and at Antwerp are several portraits of individuals. His portrait picture of his own family is at Brunswick. His faces are life-like, his handling vigorous, and his coloring transparent, although somewhat too red to be quite natural.

Ravignan, rä-vĕn-yäṅ, **Gustave Xavier Lacroix de,** French Jesuit pulpit orator: b. Bayonne 1 Dec. 1795; d. Paris 26 Feb. 1858. He had already enlisted in the Bourbon cause in 1815, and, after juristic studies, been made auditor of the Paris supreme court (1817) and substitute attorney-general (1821), when in 1822 he entered the Jesuit novitiate at Montrouge. In July 1828 he was ordained priest, and subsequently was professor of theology at St. Acheul (1828–30) and at Brieg (Canton Wallis), Switzerland. He returned in 1835 to France, where he was for five years head of the Jesuit establishment at Bordeaux. In 1837 he took the place of Lacordaire (q.v.) at Notre Dame, and continued the «conferences» there until 1846. He spoke with much simplicity, but with intense conviction. Crowds flocked to hear him, the cathedral being, it is said, often filled hours before the sermon began. He has been considered one of the greatest preachers of his time. Among his writings were: ‘De l'Existence et de l'Institut des Jésuites’ (1844; 7th ed. 1855); and ‘Clément XIII. et Clément XIV.’ (1854). Consult the sketch by Ponlevoy (13th French ed. 1890; Eng. trans. 1873).

Ravine-deer, the name among East Indian sportsmen of the common gazelle of India (*Gazella bennetti*), which is numerous in open rocky places and on the plains from central India to Persia. See GAZELLE.

Ravogli, Augustus, American surgeon: b. Rome, Italy, 7 Feb. 1851. He was graduated from the University of Rome in 1873, studied medicine at Vienna, Prague, and Berlin, served as surgeon in the Italian army with the rank of major and came to the United States in 1880. He settled in Cincinnati, Ohio, in 1881, and shortly after became professor of dermatology and syphilography at the University of Cincinnati. He has published numerous scientific articles and ‘The Hygiene of the Skin’ (1888).

Rawal Pindi, râ'ŭl pĭn'dē, India, in the Punjab, (1) the administrative capital of the division and district of its own name between the Indus and Jhilam, on the railway from Lahore to Peshawar. It is modern in appearance, well-built, and an important grain market. There are an arsenal, a fort, a fine public park, several European churches and the headquarters of the Punjab Northern State R.R. Transit trade is carried on with Cashmere and Afghanistan. The Sikhs surrendered here, and in 1885 a great durbar or review was held. Pop. about 90,000. (2) The Rawal Pindi division comprises four districts with a total area of 15,435 square miles. The district contains many towns connected with the campaign of Alexander the Great. Pop. 3,560,699.

Rawdon, Francis. See HASTINGS, FRANCIS RAWDON.

Rawhide, a form of leather in which the curing process stops short of destroying the life of the material. The result is a material remarkable for toughness, durability, tensile strength, and pliancy. It is used for belting rope, hydraulic packing, laces of various kinds, pinion wheels, washers, harness, mauls and mallets, trunks, saddles, artificial limbs, whips, lariats, etc.

Rawle, râl, **William,** American lawyer: b. Philadelphia, Pa., 28 April 1759; d. there 12 April 1836. He studied law in New York and in London, was admitted to the Pennsylvania bar in 1783, in 1791 was appointed by Washington as district attorney of Pennsylvania, and in 1794 assisted in the prosecution of the offenders in the Whiskey Rebellion. He acted as counsel for the United States Bank for many years, was chancellor of the Associated Members of the Bar of Philadelphia, and of the Law Association of that city, and was a trustee of the University of Pennsylvania from 1796 until his death He assisted in the revision of the civil code of Pennsylvania in 1830, was one of the founders of the Historical Society of Pennsylvania in 1824, serving as its first president, and was also president of the Abolition Society. He published: ‘A View of the Constitution of the United States’ (1825); ‘Discourse on the Nature and Study of the Law’ (1832); etc. Consult Wharton, ‘Memoir of William Rawle’ (1840).

Rawle, William Henry, American lawyer: b. Philadelphia 31 Aug. 1823; d. 19 April 1889. He was graduated at the University of Pennsylvania in 1841 and three years later was admitted to the bar, where he rapidly attained prominence. He enlisted in the Union army during the Civil War (1861) and re-enlisted in 1863, then serving as quartermaster. He was vice-provost of the Law Academy (1865–73) and vice-chancellor of the Law Association from 1880 to the time of his death. He published: ‘Law of Covenants for Title’ (1852); ‘Equity in Pennsylvania’ (1868); ‘The Lease of the Educated Unemployed’ (1885).

Rawlins, râ'lĭnz, **John Aaron,** American military officer: b. East Galena, Ill., 13 Feb. 1831; d. Washington, D. C., 6 Sept. 1869. He took up the study of law and in 1854 began practice in his native town. In 1861, soon after the storming of Fort Sumter, he made a brilliant war speech at a meeting presided over by Ulysses S. Grant, who was so greatly impressed that he requested Rawlins to act as his assistant adjutant-general. He then entered the army, and throughout the war was Grant's closest friend and adviser. He took an active part in the campaigns of 1862–3, and was appointed brevet major-general 13 March 1865. He was a man of marked ability as a soldier, although he never had military training. General Sherman said that Rawlins «was an intense thinker and a man of vehement expression; a soldier by force of circumstances rather than of education or practice, yet of infinite use to his chief throughout the war and up to the time of his death.» He was secretary of war during Grant's first administration.

Rawlins, Joseph Lafayette, American legislator: b. Salt Lake County, Utah, 28 March 1858. He received a classical education at the University of Indiana, but was not graduated, and was a professor at the University of Deseret in Salt Lake City 1873–5. He was admitted to the bar in 1875 and practised until 1892, when he was a successful candidate for Congress. Defeated for a second term in 1895 he was elected to the United States Senate in 1897, where in 1902 he was a member of the Committees on Foreign Relations, Immigration, Geological Survey, Indian Affairs, Pacific Railroads, Public Buildings and Grounds, and the Philippines.

Rawlins, Wyo., city, county-seat of Carbon County; on the Union Pacific Railroad; about 135 miles west by north of Laramie. It is the commercial centre of an extensive stock raising and mineral region. Its manufactures are chiefly for local use; but the railroad shops give employment to a number of persons. It ships annually a large amount of minerals, sheep, wool, and live cattle. The State Penitentiary is at Rawlins. Pop. (1890) 2,235; (1900) 2,317; (1910) 4,256.

Rawlinson, râ'lĭn-sŏn, **George,** English Orientalist: b. Chadlington, Oxfordshire, 23 Nov. 1815; d. London 6 Oct. 1902. Educated at Oxford, he took orders and was made a fellow and tutor of Exeter College in 1840. In 1845 he became sub-rector, delivered the Bampton lectures in 1859, and in 1861 was made Camden professor of ancient history. He received from Mr. Gladstone a canonry of Canterbury Cathedral in 1872, and in 1888 accepted the living of All Hallows, Lombard Street, London. An indistinct utterance interfered with his public speaking and his pulpit was mainly filled by proxy. His learning was large and various and his services to Biblical scholarship of the highest importance. With his brother, Sir Henry Rawlinson (q.v.), and Sir George Wilkinson he published an annotated edition of Herodotus (1858–60). Among his other works are: ‘The Historical Evidences of the Truth of Scripture Records’ (1860); ‘The Five Great Monarchies of the Ancient World’ (1862–7); ‘Historical Illustrations of the Old Testament’ (1871); ‘The Sixth Great Oriental Monarchy, or the Geography, History, and Antiquities of Parthia’ (1873); ‘The Seventh Great Monarchy’ (Persian Empire) (1876); ‘The Origin of Nations’ (1877); ‘Saint Paul in Damascus and Arabia’ (1877); ‘History of Ancient Egypt’ (1881); ‘Religions of the Ancient World’ (1882); ‘The Antiquity of Man Historically Considered’ (1882); ‘The Early Prevalence of Monotheistic Beliefs’ (1883); ‘Egypt and Babylon from Scripture and Profane Sources’ (1884); ‘Religious Teachings of the Sublime and Beautiful in Nature’ (1884); ‘Ancient History’ (1887); ‘Ancient Egypt’ (1887); ‘Moses: His Life and Times’ (1887); ‘A History of Phœnicia’ (1889); ‘Isaac and Jacob: Their Lives and Times’ (1890); ‘Parthia’ (1893); and others in the department of Biblical commentary.

Rawlinson, Sir **Henry Creswicke,** English diplomatist and Orientalist: b. Chadlington, Oxfordshire, 4 Nov. 1810; d. London 5 March 1895. He went to Bombay in 1827 as a military cadet in the service of the East India Company, at once applied himself assiduously to the study of the Oriental languages, and was soon in request as an interpreter. After five years' service with the First Bombay Grenadiers, he was employed in military work in Persia (1833–9). His stay in Persia had made him acquainted with the cuneiform inscriptions at Behistun, and on being appointed in 1844 consul at Bagdad he set himself to copy and decipher the chief inscription. The result was his great paper on ‘The Persian Cuneiform Inscription at Behistun,’ printed in the ‘Journal of the Royal Asiatic Society’ in 1846. Though not without important predecessors in the same field, Rawlinson is justly regarded as the chief founder of the study of Persian cuneiform, and the first successful decipherer of cuneiform writings. Having shown great zeal and ability in the discharge of political duties, he was raised in 1851 to the rank of consul-general. Resigning in 1855, he returned to England, and in 1856 was created K.C.B., promoted lieutenant-colonel, and appointed a crown director of the East India Company. In 1858 he was elected to the House of Commons for Reigate as a conservative, and again sat there in 1865–8 as member for Frome. In 1859–60 he was minister-plenipotentiary at Teheran, in 1889 became a G.C.B., and two years later was created a baronet. Rawlinson received many honors both at home and from foreign countries. He was president of the Royal Asiatic Society in 1878–81 and of the Royal Geographical Society in 1871–2 and 1874–5. His chief published works are: ‘Cuneiform Inscriptions of Western Asia’ (1861–80; 2d ed. of Vol. I., 1891), with E. Norris, G. Smith, and T. G. Pinches; ‘England and Russia in the East’ (1875), a strongly anti-Russian pamphlet; notes in the translation of ‘Herodotus’ by his brother, George Rawlinson (q.v.), and many papers in the journals of the Royal Asiatic and Royal Geographical Societies. See the ‘Life’ by his brother (1898), with an introduction by Earl Roberts.

Rawnsley, rânz'lĭ, **Hardwick Drummond,** English Anglican clergyman and poet: b. Henley-on-Thames 28 Sept. 1850. He was educated at Oxford, took orders in 1875, was vicar of Wray, Windermere, 1878–83, and has been vicar of Crosthwaite, Keswick, from the last named date. Among his many published works are: ‘Sonnets Round the Coast’; ‘Sonnets at the English Lakes’; ‘Literary Associations of the English Lakes’; ‘Village Sermons’; ‘Sonnets in Switzerland and Italy’ (1899); ‘Memories of the Tennysons’ (1900); ‘Ruskin and the English Lakes’ (1901); ‘A Rambler's Note Book at the Lakes’ (1902).

Rawson, râ'sŏn, **Albert Leighton,** American author and artist: b. Chester, Vt., 15 Oct. 1829; d. New York November 1902. He studied law, theology, and art and traveled extensively in the Orient, later exploring the Indian mounds in the Mississippi Valley, and traveling in Central America and in the Hudson Bay territories. He founded the Theosophical Society in the United States, was adopted into the tribe of the Adwan Bedouins of Moab and initiated by the Druses in Mount Lebanon. His books, illustrated by his own maps and drawings, include: ‘Bible Dictionaries’ (1870–5); ‘Antiquities of the Orient’ (1870); ‘Vocabulary of the Bedawin Languages of Syria and Egypt’ (1874); ‘Chorography of Palestine’ (1880); ‘The Unseen World’ (1888); ‘History of Mysticism’; etc.

Rawson, Edward Kirk, American educator: b. Albany, N. Y., 21 Feb. 1846. He was graduated from Yale in 1868, from Andover Theological Seminary in 1872, and was ordained in the Congregationalist ministry. In 1871–90 he was chaplain in the United States navy, serving at the Naval Academy from 1886, and in 1888–90 professor of ethics and English there. In 1897–1902 he was superintendent of naval war records and in 1902 he resumed his chair at the Naval Academy. He has published ‘Twenty Famous Naval Battles: Salamis to Santiago’ (1899).

Ray, Anna Chapin, American author of juvenile fiction: b. Westfield, Mass., 3 Jan. 1865. She was graduated at Smith College 1885 and in 1888 received the degree of A.M. She has published ‘Half a Dozen Boys’ (1890); ‘Half a

Dozen Girls' (1891); 'Dick' (1896); 'Each Life Unfulfilled' (1899); 'Bumper and Baby John' (1903); 'By the Good Sainte Anne' (1905).

Ray, George W., American lawyer and politician: b. Otselic, Chenango County, N. Y., 3 Feb. 1844. He was educated at Norwich Academy; served in the Civil War as private and brigade clerk; then studied law, was admitted to the bar in 1867, and established a successful practice. In 1882 he was elected to Congress as a Republican, and served till 1885, and again from 1891 to 1903. He opposed the free silver bill of 1892, was chairman of the committee on invalid pensions and of the committee on judiciary. In 1902 he was made United States district judge for northern New York.

Ray, Isaac, American physician: b. Beverly, Mass., 16 Jan. 1807; d. Philadelphia, Pa., 31 March 1881. He was graduated from Bowdoin in 1827, practised medicine, and in 1841–5 was superintendent of the state insane asylum at Augusta, Maine. In 1845–66 he had charge of the Butler Hospital for the Insane at Providence, R. I., and then removed to Philadelphia, where he engaged in medical practice. He published: 'Conversations on Animal Anatomy' (1829); 'Medical Jurisprudence of Insanity' (1838); 'Education in Relation to the Health of the Brain' (1851); 'Mental Hygiene' (1863); 'Contributions to Mental Pathology' (1873); etc.

Ray, John (at an earlier period spelled by him WRAY), English naturalist: b. Black Notley, near Braintree, Essex, 29 Nov. 1627; d. there 17 Jan. 1705. He was educated at Trinity College, Cambridge, was made Greek lecturer in 1651, mathematical lecturer in 1653; humanity reader in 1655, and junior dean in 1658. He made long botanical and zoological tours in England, Scotland, and Wales; and in 1663–6 traveled about Europe with Francis Willoughby in an attempt to accomplish a systematic description of the entire organic world. It is thought that much of the credit bestowed on Ray as the founder of English natural history should properly attach to Willoughby. Ray was elected F.R.S. in 1667. Among his works are 'Catalogus Plantarum Angliæ' (1670), the basis of all subsequent English floræ; 'Methodus Plantarum Nova' (1682), giving a new system of classification; 'Historia Plantarum' (1686–1704). In 1844 the Ray society was founded at London for the publication of scientific works of established merit. Consult the 'Memorials' by Lankester (1844).

Ray, a group of elasmobranchs forming the suborder *Batoidei*. The skates and the rays are nearly allied to each other, and are recognized by their broad flattened bodies, which are generally of a rhomboidal shape, and consist in greater part of the enormously developed pectoral or breast fins, which are supported upon a modified portion of the anterior skeleton. On the upper surface of the disk-like body the eyes are borne, together with spiracles or apertures, by which water may be admitted to the gill-sacs. The mouth, nostrils, and gill-openings (five on each side) are in the lower surface of the body. The mouth is generally furnished with broad flat teeth of rhomboidal shape, and is of small size. The tail is elongated and slender, and is generally armed with sharp spinous processes. (See STING-RAY.) Two or more dorsal fins may exist, whilst the caudal or tail fin is heterocercal. These fishes produce eggs, which, like those of sharks, are enclosed in cartilaginous capsules, known as "mermaids' purses," etc. Occasionally the rays may attain very large dimensions, and weights. They are bottom-fishes, and feed upon other small fishes, crustaceans and mollusks. They swim chiefly by peculiar undulating motions of the edges of the pectoral fins. In the true rays (*Rajidæ*) the snout is more or less pointed and prolonged, and two dorsal fins exist near the end of the tail. The most common members of this group are the sting-rays (q.v.). The European sharp-nosed ray (*R. oxyrhynchus*) is a favorite French food-fish; the homelyn ray (*R. maculata*), also, is frequently sold in the London markets. The American species are called skates (q.v.). The eagle rays (*Myliobatidæ*) possess projecting heads, with the pectoral fins extended laterally in a great degree so as to imitate wings. The teeth are hexagonal, flat, and pavement-like. The slender tail possesses one dorsal fin, and is armed with a notched spine. These include the California "batfish" (*Myliobatis californicus*), and a famous whip-tailed species of the Mediterranean (*M. aquila*). Allied to these are the huge blanket-rays (*Mantidæ*), so much dreaded by swimmers and divers in all warm seas. Specimens weighing more than 1,000 pounds have been taken in the Mediterranean. (See DEVIL-FISH.) Other families are the sawfishes (*Pristidæ*), the guitar-fishes (*Rhinobatidæ*) and the electric rays or torpedoes (*Narcobatidæ*), elsewhere described. See FISHES; ICHTHYOLOGY.

Rayahs, rā'yäz, the Christian peasantry, laborers, and small farmers, who lived under Turkish rule, or rather misrule, in the Balkan peninsula. The word means "cattle," and as cattle these people were treated by their Turkish masters in Bosnia, Servia, Bulgaria, and the neighboring states.

Rayleigh, rā'lĭ, **John William Strutt**, BARON, English physicist: b. 12 Nov. 1842. He was educated at Cambridge and became a fellow of Trinity College in 1866. From 1879 till 1884 he was professor of experimental physics at Cambridge; from 1887 to 1905 was professor of natural philosophy in the Royal Institution; was secretary to the Royal Society from 1887 till 1896; and since the latter year has been scientific adviser to Trinity House. Beside contributions to the proceedings of scientific societies, he has written the article 'Optics' in the 'Encyclopædia Britannica' (9th edition) and 'The Theory of Sound' (1877–8; new ed. 1894–6). He was associated with Prof. William Ramsay in the latter's discovery in atmospheric nitrogen of a new gas, called by them argon, for which in 1904 he was awarded the Nobel prize in physics. He became lord chancellor of Cambridge University 10 April 1908.

Raymond VI., rā'mŏnd, **count of Toulouse**: b. 1156; d. 1222. He succeeded to the territory in 1194. He protected the Albigenses, against whom Pope Innocent III. sent an army in 1208 to avenge the assassination of his legate. Raymond's territories were ravaged, he himself excommunicated and his lands given over to Simon de Montfort. After the death of de Montfort at the siege of Toulouse in 1218 Raymond recovered his territories. But again espousing the cause of the Albigenses he was once more excommunicated.

Raymond VII., son of Raymond VI., and last count of Toulouse: b. 1197; d. 1242. He engaged with his father for the recovery of Toulouse from Simon de Montfort, and finally forced the latter's son Amalric, to a complete surrender. Forced to make peace with the Pope and the king of France in 1229, he ceded Narbonne and other estates to Louis IX. He made Alphonse, Count of Poitiers, his heir.

Raymond, Andrew Van Vranken, American college president: b. Visscher's Ferry, N. Y., 8 Aug. 1854. He was graduated at Union College 1875, and at the New Brunswick Theological Seminary 1878. He was pastor of the First Reformed Church, Paterson, N. J., 1878–81; Trinity Reformed Church, Plainfield, N. J., 1881–7, and of the Fourth Presbyterian Church, Albany, N. Y., 1887–94. He has been president of Union College since 1894.

Raymond, Bradford Paul, American Methodist clergyman: b. Stamford, Conn., 22 April 1846. He was graduated from the Theological School of Boston University, and ordained to the Methodist Episcopal ministry in 1874. He held successive pastorates in New Bedford, Mass., Providence, R. I., and in Nashua, N. H., and was president of Lawrence University from 1883–9. From 1889 until his resignation in 1907 he was president of Wesleyan University, Middletown, Conn. He has published 'Christianity and the Christ.'

Raymond, Evelyn Hunt, American writer of juvenile fiction: b. Watertown, N. Y., 6 Nov. 1843. In 1869 she was married to J. B. Raymond and at present (1904) resides in Baltimore. Among her many popular books may be cited: 'Little Red Schoolhouse' (1897); 'A Daughter of the West' (1899); 'Reels and Spindles' (1900); 'The Sun Maid' (1900); 'A Daughter of the Forest' (1902).

Raymond, George Lansing, American educator: b. Chicago, Ill., 3 Sept. 1839. He was graduated from Williams College in 1862 and from Princeton Theological Seminary in 1865. Entering the Presbyterian ministry he was pastor at Darby, Pa., 1869–73; professor of oratory at Williams 1874–80; was professor of oratory and æsthetic criticism at Princeton 1880–93 and of æsthetics at Princeton from 1893. Among his many published works in verse and prose are: 'Life in Song' (1886); 'Poetry as a Representative Art' (1886); 'Ballads of the Revolution' (1887); 'The Representative Significance of Form' (1900); 'The Aztec God and Other Dramas' (1902).

Raymond, Henry Jarvis, American journalist: b. Lima, N. Y., 24 Jan. 1820; d. New York 18 June 1869. He was graduated from the University of Vermont in 1840, went to New York, studied law, and contributed to 'The New Yorker,' a literary weekly published by Horace Greeley. Upon the establishment of the New York *Tribune* in 1841 he became assistant editor. While editorially connected with the 'Courier and Enquirer' (1843–51) he engaged with Greeley in a spirited controversy on the subject of Fourierism, which had at that time taken a strong hold upon the American people resulting in the establishment of communities more or less resembling Brook Farm. He was elected to the State Assembly in 1849 and 1850, the latter year becoming speaker. In 1851 he established the New York *Times*, the first number being issued on 18 September. In 1854 he was elected lieutenant-governor of the State. He was one of the prominent organizers of the Republican party, and drew up the "Address to the People," promulgated by its first national convention held in Pittsburg February 1856. His choice for President in 1860 was William H. Seward, and he used his influence to place him in the cabinet after Lincoln's election. After the disaster at Bull Run he proposed a provisional government, feeling that Lincoln's policy was too hesitating. He was again member of the Assembly in 1861, where he was chosen speaker; and in 1864 was elected to Congress, giving his support to President Johnson's policy. He was the author of the "Philadelphia Address" to the people of the United States, promulgated by the National Union Convention, which he helped to organize in 1866. He was an effective public speaker, and exerted a marked influence on the elevation of the tone of journalism. He wrote 'Political Lessons of the Revolution' (1854); 'Letters to Mr. Yancy' (1860); 'History of the Administration of President Lincoln' (1864); 'Life and Services of Abraham Lincoln' (1865). Consult Maverick, 'Henry J. Raymond and the New York Press for Thirty Years' (1870).

Raymond, John Howard, American educator: b. New York 7 March 1814; d. Poughkeepsie 14 Aug. 1878. He took his degree at Union College in 1832, entered the Baptist ministry, and in 1839 became professor of rhetoric and English literature at Madison University, and in 1850 removed to the newly established Rochester University as professor of belles-lettres. As an organizer of educational institutions he showed remarkable aptitude, performing that service for the Collegiate and Polytechnique Institute in Brooklyn in 1856 and for Vassar College in 1865. He filled the post of president and professor of mental and moral science at Vassar until his death. Consult his 'Life and Letters' (1880).

Raymond, John T., American actor: b. Buffalo, N. Y., 5 April 1836; d. Evansville, Ind., 10 April 1887. His original name was John O'Brien. His first appearance was at Rochester in June 1853, as Lopez in 'The Honeymoon.' In 1861 he made a great hit as Asa Trenchard in 'Our American Cousin,' and in 1867 went to England and appeared in this character in the company of E. A. Sothern, who was the famous Lord Dundreary. In 1874 he achieved his greatest success as Colonel Mulberry Sellers in a dramatization of Mark Twain's 'Gilded Age.' He was widely popular and depicted certain types of broad, humorous character with great success.

Raymond, Rossiter Worthington, American mining engineer: b. Cincinnati, O., 27 April 1840. He was graduated from the Brooklyn Polytechnic Institute in 1858 and spent three years in study at Freiburg, Munich, and Heidelberg. Returning from Europe he entered the Union army and served from 1862 to 1864 as additional aide-de-camp with the rank of captain. From 1864 to 1868 he was consulting engineer in New York, at the end of which time he was appointed United States commissioner of mining statistics and held this post until 1876. From 1870 to 1882 he was lecturer on economic geology at Lafayette College. In 1875 he became New York state commissioner of electric subways for the city of Brooklyn. One of the original members of the American Institute of Mining Engineers, he became its vice-president in 1871, was its president 1872–4, and secretary 1884–8. He is a member of scientific and technical societies in Europe and America, including the Society of Civil Engineers of France. In 1903 he became lecturer on mining law in Columbia University. He has published: 'Reports on the Mineral Resources West of the Rocky Mountains' (1869–76); 'The United States Mining Industry'; 'Mines, Mills, and Furnaces'; 'Silver and Gold'; 'Brave Hearts,' a novel (1873); 'The Man in the Moon and Other People' (1874); 'The Book of Job' (1878); 'Camp and Cabin' (1880); 'A Glossary of Mining and Metallurgical Terms' (1881); 'Memorial of Alexander L. Holly' (1883); 'Life of Peter Cooper' (1901).

Raymond, Walter, English novelist: b. Yeovil, Somerset, 13 March 1852. He was educated at private schools, and was partner in a glove manufactory, but in 1895 gave up business for literature. Among his works, several of which appeared under the pseudonym "Tom Cobbleigh" are: 'Misterton's Mistake' (1890); 'Gentleman Upcott's Daughter' (1894); 'Love and Quiet Life' (1894); 'Tryphena in Love' (1895); 'Two Men o' Mendip' (1898); 'The Idler Out of Doors' (1901).

Raymond, William Galt, American civil engineer: b. Princeton, Ia., 2 March 1859. He was graduated at Washington University as a civil engineer in 1884; was instructor of civil engineering at the California State University 1884–90; was professor of geodesy, road engineering, and topographical drawing at the Rensselaer Polytechnic Institute 1892–1904, and since 1904 professor of civil engineering and director of the School of Applied Sciences at Iowa State University. He has published 'Plane Surveying' (1896).

Raymond, Battle of. After the battle of Port Gibson (q.v.), 1 May 1863, the Confederates fell back beyond the Bayou Pierre and destroyed the bridges. Gen. Grant followed on the 2d, occupied Port Gibson, and the same evening the Confederates continued their retreat across Big Black River, at Hankinson's Ferry, leaving a force behind to prevent the crossing, which was attacked on the morning of the 3d by Crocker's division of McPherson's corps. The Confederates stoutly contested the ground, retiring very slowly, until late in the day, when Logan's division came upon their flank, when they hastily crossed the river. McPherson's corps was moved forward to Hankinson's Ferry and McClernand's to Willow Springs, where they remained until the 7th, when, Sherman's corps having crossed the Mississippi, the advance was resumed, the main body of the army moving along the line of the Big Black toward Edwards' Station, midway between Vicksburg and Jackson, while McPherson, on the right, was directed upon Jackson, the capital of the State, 45 miles east of Vicksburg, and the geographical and railway centre of the State. On the night of the 11th McPherson bivouacked five miles northeast of Utica, on the road to Raymond, and early in the morning pushed rapidly for Raymond, 18 miles from Jackson, hoping to capture some commissary stores, but before 9 A.M. Logan's division, in the advance, encountered a strong body of the enemy, upon which the division was deployed and continued its advance for two hours, when, coming to a small stream crossing the road about two miles from Raymond, Gen. Gregg's brigade of about 3,000 men, with two batteries, was seen beyond the stream, disposed to enfilade the road and bridge over the stream. Logan threw out skirmishers and advanced, bringing on a severe engagement, which continued more than two hours, when the leading brigade of Crocker's division came up to his support, upon which Gregg, leaving two disabled guns, abandoned the field and retreated toward Jackson, being joined on the way by Walker's brigade, and when overtaken by night, bivouacking five miles from the field. The Union loss was 66 killed, 339 wounded, and 37 missing. Gregg reported a loss of 73 killed, 229 wounded, and 204 missing. Consult: 'Official Records,' Vol. XXIV.; Grant, 'Personal Memoirs,' Vol. II.

E. A. CARMAN.

Raynaud's (rā-nōz') **Disease,** a vasomotor affection, occurring mostly in children and young adults, and characterized by coldness and whiteness of the toes, the tips of the fingers, the end of the nose and sometimes of the lobes of the ears. It may exist with other functional nervous disorders, such as hysteria and neuralgia, and occurs especially in persons of neurotic heredity or temperament. It was first studied by Raynaud in 1862. He believed that the local manifestations are due to constrictor spasm, probably originating in the gray centres of the spinal cord. No central lesions have been found. After exposure to cold, the toes, fingers, nose, etc., become cold, numb, and white (local syncope), and pricking draws no blood. When warmth and color return, there is frequently pain, also congestion, swelling and a purple color (local asphyxia). Either of these stages may be recovered from, or the second stage may end in gangrene of the parts (Raynaud's gangrene, local or symmetrical gangrene). Recurrences of the disease are common. The prognosis is not good, especially in debilitated children. For treatment avoid cold, use warm baths, electricity, and massage. Ichthyol ointment sometimes alleviates the pain. Other remedies should be advised by the physician.

Rayner, rā'nėr, **Emma,** American novelist: b. Cambridge, England. She was graduated from Cambridge University, came to this country and was employed on the staff of the 'Youth's Companion' (1896–1902). She has published: 'Free to Serve' (1897); 'In Castle and Colony' (1899); 'Visiting the Sin' (1900); 'Doris Kingsley: Child and Colonist' (1901); 'Handicapped Among the Free' (1903).

Rayner, Isidor, American lawyer and politician: b. Baltimore, Md., 11 April 1850. He received his education at the University of Virginia, and entering on the practice of law, soon became one of the leaders of the Baltimore bar. In 1878 he was elected to the State legislature, serving later for four years in the State senate. In 1887 he entered Congress as a member of the House of Representatives, where he participated in important legislation, and in February 1904 was elected to the United States Senate.

Raynouard, François Juste Marie, frăñ-swă zhüst mä-rē rä-noo-är, French poet and philologist: b. Brignoles, department of Var, 8 Sept. 1761; d. Passy 17 Oct. 1860. He studied for the bar at Aix and practised law at Draguignan with great success. Elected a deputy to the Legislative Assembly in 1791, he attached himself to the Girondins, and on the proscription of that party was thrown into prison. The fall of Robespierre set him at liberty, whereupon he resumed his profession of advocate in his native province and acquired a fortune. Having previously made two unsuccessful attempts to live by his pen, he once more settled in Paris, and wrote 'Socrate dans le Temple d'Aglaure' (1802), a poem which obtained a prize from the Institute. This was followed by two tragedies, 'Eléonore de Bavière' and 'Les Templiers,' the latter performed at the Théâtre Français in 1805 by order of Napoleon. In 1806 he was elected a member of the Corps Législatif. In 1817 he was nominated perpetual secretary of the Academy, a post he resigned in 1826, when the ministry presented to the chambers a bill which had for its object the limiting of the liberty of the press. Of most value to the world is the work in the field of Romance philology, his writings including: 'Grammaire comparée des Langues de l'Europe Latine dans leurs Rapports avec la Langue des Troubadours' (1821); 'Choix des Poésies originales des Troubadours' (1816–21); 'Lexique Roman, ou Dictionnaire de la Langue des Troubadours comparée aux autres Langues de l'Europe Latine' (1836–44); 'Observations Philologiques sur le Roman de Rou, et sur quelques Règles de la Langue des Trouvères au XIIe Siècle' (1829).

Razin, ră'zĕn, **Stenko,** Russian bandit: b. —; d. Moscow 1671. He was the leader of Cossacks who plundered caravans and fisheries along the Volga. Being captured he was pardoned by Alexis, but rebelled again, and gathered about himself the dissatisfied elements, captured cities and ruled along the Volga as far as Nijni-Novgorod. He was finally taken and executed at Moscow. Thereupon he became the hero of epic song of the 17th century and was regarded as the champion of the people against the nobles. Magic powers were attributed to him.

Razor, the well-known keen-edged instrument for shaving off the beard or hair. Razors seem to have been in use at a very early period of the world's history. They were used by the ancient Egyptians. The Levitical code expressly forbade the shaving of the beard, and many Jews in some countries remove all superfluous hair with the scissors until this day. It is believed by many authorities that the primitive shaving-instruments were made of sharpened flints; the savages of Polynesia still use two pieces of flint of the same size, or pieces of shells or sharks' teeth ground to a fine edge, for this purpose. Among civilized nations the blade is metal, usually steel, the finest cast steel being preferred. The handles are made of a great variety of materials, as silver, ivory, tortoise-shell, bone, horn, etc. The Chinese and Japanese razors are very rarely furnished with handles.

Razor-bill, or **Tinker,** a species of auk (*Alca torda*) intermediate in structure between the guillemots and the great auk; but characterized by its compressed, elevated, hooked, and furrowed bill, its peculiar stiff wedge-shaped tail and ample wings. It is about 18 inches long, generally black above and white below; but in the breeding plumage the head and neck become lustrous black all around, with a very characteristic fine white line running from the eye to the base of the bill. This bird is abundant in the North Atlantic, frequenting rocky islands and coasts to breed with puffins and guillemots, but at other seasons keeping farther out at sea, and in winter migrating as far south as the Mediterranean and the coast of New Jersey or even North Carolina. On the American side it breeds in the Bay of Fundy and in great colonies in the Gulf of St. Lawrence, about Labrador, etc. A single much blotched and streaked whitish egg, about three inches long, is deposited on a ledge or in a fissure of some precipitous rocky cliff. They feed upon floating refuse or fish, worms, etc., for which they dive or which they pursue in the water, using both wings and feet in swimming. When molested they sometimes fight viciously, at the same time uttering harsh cries. The large eggs are much gathered for food.

Razor-clam, or **Razor-fish,** a bivalve mollusk of the family *Solenidæ,* known on all sandy shores. The shell is long and narrow, like a razor-handle, and gapes at both ends, the siphons are short, the foot is large and powerful. The shell is handsomely ornamented and in some tropical species is of great beauty. These mollusks always live buried in the sand in an upright position, leaving only an opening shaped like a keyhole, which corresponds with the two siphon tubes. They are generally found at a depth of one or two feet, and when they make their burrows, as they are often in the habit of doing, among the rocks, not even an iron hook can draw them from their retreat, but they may sometimes be beguiled by pouring salt water on the spot, deceiving them into the impression that the tide has risen and they may begin to feed. They are edible, but rather tough. A familiar and typical species on the eastern coast of the United States is *Ensis americana.* Consult Kingsley, 'Standard Natural History,' Vol. I. (1885).

Razorback, one of the large whales of the genus *Balænoptera,* called also finbacks and rorquals. (See FINBACK; WHALE.) Also a name for the thin and agile semi-wild hogs which range the woods in the less settled parts of the southern United States.

Re, rā, the sun god, first and most important of Egyptian divinities. Re is supposed to be the son of Neith (q.v.), the goddess of the upper air, and to have had for his wife Mout, the mother of nature. He had for children Athor, the light; Mu, the sunlight; and Mat, spiritual light, and was widely worshipped by the ancient Egyptians, and in course of time every local divinity became identified with Re; thus, Ammon became Ammon-Re; Sobk changed to Sobk-Re. The attempt to unify the personages of mythology under Re and thus erect a monotheism is credited to Amenophis IV. of the 18th dynasty.

Ré, rā, or **Rhé, Île de**, France, a small, low-lying island three miles distant from the coast of the department of Charente-Inférieure, opposite the city of La Rochelle, from which it is separated by the Pertuis Breton. It is about 18 miles long and three broad and measures 28 square miles. The inhabitants are chiefly engaged in the preparation of salt, producing 32,000 tons annually. The west coast is rocky; on the east side there are some good harbors. Oyster farming has become an important branch of industry yielding 35,000,000 annually. Wine is made and exported. The chief town, St. Martin, was fortified by Vauban. Pop. of island about 15,000.

Reaction, in chemistry, a general term for any chemical change that is brought about by the mutual interaction of two or more substances. Reactions between two primitive substances may be conveniently divided into three classes, as follows: (1) Those in which the two substances combine additively, so as to form a single third substance by their union. (2) Those in which one of the primitive substances is broken up, the other primitive substance combining additively with one or all of its parts, so as to produce two or more new substances. (3) Those in which there is a double decomposition of the two primitive substances, the several parts of the first combining with those of the second so as to produce two or more new substances. The first of these is illustrated by the action of oxygen gas upon metallic sodium, the combination taking place additively according to the equation $2Na + O = Na_2O$. The second is illustrated by the action of chlorine gas upon an excess of methane (CH_4); methyl chloride and hydrochloric acid being formed (upon exposure to diffuse daylight) in accordance with the equation $CH_4 + 2Cl = CH_3Cl + HCl$. The third general type of reaction between two primitive substances (that, namely, in which there is a double decomposition) may be illustrated by the action of hydrochloric acid upon caustic potash, KOH, as indicated by the equation $KOH + HCl = H_2O + KCl$, the products of the reaction being water and chloride of potassium.

To describe chemical reactions in detail would be to discuss the entire subject of chemistry. Reference must therefore be made to the many articles in this encyclopædia in which different types of reactions are described. See, for example, Aromatic Compounds; Benzene; Chemistry; Equilibrium, Chemical; Fatty Compounds; Solutions; etc.

Read, rēd, **George**, American patriot and jurist, one of the signers of the Declaration of Independence: b. Cecil County, Md., 18 Sept. 1733; d. New Castle, Del., 21 Sept. 1798. He was educated at Chester, Pa., studied law, and was admitted to the bar in Philadelphia, soon afterward settling in New Castle, Del., where he practised his profession. He served as attorney-general for the crown for the counties of Delaware, Kent, and Sussex from 1763 to 1764, when he was elected a member of the first Continental Congress. Early an opponent of independence, at last he saw no alternative, and signed the petition to George III. and the Declaration itself. He was chairman (1775–7) of the first naval committee of the colonies, and is to be considered as one of the chief founders of the primitive American navy. The new constitution of Delaware (1776) was drafted by him, and he was president of the convention which adopted it. He was made vice-president and acting president (governor) of the State of Delaware, whose laws he codified. In 1782 he was appointed judge of the United States Court of Appeals for Admiralty Cases. He was a delegate to the Annapolis Convention (1786) and to the Constitutional Convention (1787), and was elected to the United States Senate in 1789 and in 1791. Resigning in 1793, he became chief justice of Delaware, and held that office during the rest of his life.

Read, John Elliot, American journalist: b. Farmer,' Philadelphia, for 12 years. He has educated in the public schools and has written much for agricultural, religious, and literary periodicals. He was associate editor of 'The Working Farmer' in New York 10 years, and was corresponding editor of 'The Practical Farmer,' Philadelphia, for 12 years. He has published: 'Farming for Profit' (1880); 'Life Triumphant: A Study of the Nature, Origin and Destiny of Man' (1900); and also wrote 'A Brief History of the Principal Earlier Arctic Explorations from the 9th Century to the Peary Expedition' as the concluding section of 'Nansen in the Frozen World' (1897).

Read, John Joseph, American naval officer: b. New Jersey; d. 24 Oct. 1910. He was graduated from the U. S. Naval Academy, 1861, served under Farragut during the Civil War, and on the Atlantic blockades, and in 1866 was promoted lieutenant-commander. He received steady advancement, was made rear-admiral in 1900 with command of the receiving-ship Richmond, and in 1901 was placed in command of the navy yard at Portsmouth, N. H.

Read, John Meredith, American jurist: b. Philadelphia, Pa., 21 July 1797; d. there 29 Nov. 1874. He was a son of George Read, signer of the Declaration of Independence, was graduated at the University of Pennsylvania in 1812, and admitted to the bar in 1818. In 1822–3 he occupied a seat in his State's legislature, and later as city solicitor drew up the first statement of the finances of Philadelphia. He was United States attorney for the eastern district of Pennsylvania in 1837–44, and served as solicitor general of the United States; attorney-general of Pennsylvania, and chief justice of that State from 1860 until his death. With the formation of the Republican party he became one of its members, and by it was elected judge of the supreme court of Pennsylvania in 1858. His name was proposed as candidate for the presidency of the United States in 1860 and several votes were actually cast for him in the Chicago convention, though he used his personal influence in favor of Abraham Lincoln. His 'Views on the Suspension of the Habeas Corpus' (1863) became the basis of the act of 3 March 1863, authorizing the President to suspend the habeas corpus act. His legal opinions extend through 41 volumes of reports, while of his published addresses the principal are: 'Plan for the Administration of the Girard Trust' (1833); 'The Law of Evidence' (1864); 'Jefferson Davis and his Complicity in the Assassination of Abraham Lincoln' (1866).

Read, John Meredith, American diplomatist: b. Philadelphia, Pa., 21 Feb. 1837; d. Paris 27 Dec. 1896. He was a son of Judge Meredith Read (q.v.), was graduated at Brown University, and at the Albany Law School in 1859. He pursued the study of international law in Europe, was admitted to the bar in Philadelphia, and settled at Albany. From 1860 to 1866 he was adjutant-general of the State of New York. In 1869 he was appointed United States consul for France and Algeria, and during the period of the Franco-Prussian war he acted as consul-general for the German government, for which he received the thanks of both the French and German governments, and personal recognition of his services from Prince Bismarck. From 1873 to 1879 he was United States minister to Greece, and during the latter part of his tenure of office personally paid the expenses of the legation, when the government refused the appropriation. His important services during his term were his securing the revocation by the Greek government of an order prohibiting the sale of the Bible in Greece; the release of the American ship Armenia, and the report of an open Russian port during the Turkish war, to which he urged the despatch of a grain fleet. After his relinquishment of diplomatic duties he continued to reside in Europe, engaged in archæological, historical, and art studies. He was the author of a 'Historical Inquiry Concerning Henry Hudson' (1866).

Read, Nathan, American inventor: b. Warren, Worcester County, Mass., 2 July 1759; d. near Belfast, Maine, 20 Jan. 1849. He was graduated from Harvard in 1781; studied medicine; in 1796 established with others the Salem iron foundry, where chain cables and other iron work for ships were manufactured, and in 1798 patented a nail-making machine. In 1788 he became interested in steam navigation, and as his first task attempted the construction of a boiler that should be at once compact, light, and safe. He made, in 1788 or 1789, the first drawings of what he styled his "portable furnace boiler," which was devised for use on steam carriages and steamboats, and for which he obtained a patent 26 Aug. 1791. He had built a steamboat in 1789, and by a trial of this craft, which was fitted with paddle-wheels and a crank operated by hand, was satisfied that his method of applying steam to the propulsion of vessels would work suitably. There is no evidence, however, that he succeeded in even an experimental demonstration of his plans. His model steam carriage, exhibited by him while endeavoring to obtain aid in his schemes, was never developed. He did, however, invent the vertical multi-tubular firebox boiler, which has long been in use as a standard form. Among his other inventions were several forms of pumping engines, and a plan for utilizing the force of the tide by means of reservoirs alternately so filled and emptied as to produce a continuous stream of water. Much credit belongs to Read for his early and clear perception of the importance of steam navigation. From 1800 to 1803 he was a representative in Congress, and after his removal to Maine, was for many years chief justice in the court of Hancock County. Consult: Read, 'Nathan Read' (1870); Thurston, 'A History of the Growth of the Steam Engine' (1878).

Read, Opie Percival, American journalist and novelist: b. Nashville, Tenn., 22 Dec. 1852. He was educated in Gallatin, Tenn.; entered journalism at Franklin, Ky., and later removed to Little Rock, Ark. He edited the Arkansas 'Gazette' in 1878–81; founded the 'Arkansaw Traveler' in 1883, and edited it for 10 years. He has since lived in Chicago, where he has devoted himself to literary work. His publications include: 'Len Gansett' (1888); 'Up Terrapin River' (1889); 'A Kentucky Colonel' (1890); 'My Young Master' (1896); 'In the Alamo' (1900); 'Our Josephine' (1902); etc.

Read, Thomas Buchanan, American poet and painter: b. Chester County, Pa., 12 March 1822; d. New York 11 May 1872. His father was a farmer and he received but little schooling. He lived at various times during his youth and young manhood at Philadelphia, Cincinnati, New York, and Boston, occupied in ways that satisfied his tastes, such as portrait painting and writing verses, when he could; and in other ways that supplied his necessities, such as sign painting, cigar making, play acting, when he must. He published his first verses in the Boston *Courier* in 1843–4; later a Revolutionary tale 'Paul Redding' (1845) and 'Poems' (1846), before his removal to Philadelphia, where he edited 'The Female Poets of America' (1848), and brought out his 'Lays and Ballads' (1849). In 1850 he went to Europe and joined the circle of American artists living at Rome. Here he had the first opportunity for the serious study of painting, and for the rest of his life, save for occasional visits to America, he made his home at Rome. His better known paintings are 'The Water Sprite'; 'The Lost Pleiad'; 'The Star of Bethlehem'; 'Sheridan and His Horse.' He made portraits of Mrs. Browning, the ex-Queen of Naples, Henry W. Longfellow, and a group of Longfellow's children. His portrait of George Peabody is at the Institute in Baltimore. A sculptured bust of General Sheridan was executed late in life. It is as a poet, however, that he will be remembered, especially by his stirring 'Sheridan's Ride,' written for the elocutionist and actor, James E. Murdock, and the exquisitely musical lyric 'Drifting.' His volumes of verse are 'The New Pastoral' (1855); 'Sylvia or the Last Shepherd' (1857); 'The Waggoner of the Alleghanies,' in which occurs the fine lyric 'The Maid who Binds Her Warrior's Sash' (1862). A complete edition of his poems was published in 1882.

Reade, rēd, **Charles,** English novelist and play-writer: b. Ipsden House, Oxfordshire, 8 June 1814; d. Shepherd's Bush, London, 11 April 1884. He was educated at Oxford and was called to the bar in 1843, but, finding literature more attractive than law, devoted himself to the former, and never practised. He became first known by his novel of 'Peg Woffington' (1852), which he afterward dramatized with Tom Taylor, under the title of 'Masks and Faces.' This was followed by 'Christie Johnstone' (1853), in which he showed considerable appreciation of certain characteristics of Scottish life. The appearance, in 1856, of 'Never Too Late to Mend,' one of his "novels with a purpose," in which he attacked the English prison system with, perhaps, greater zeal than unbiased judgment, secured for him a wide reputation. His next great work, the most scholarly and artistic of his writings, 'The Cloister and the Hearth,' dealing with the lives of the parents of Erasmus, appeared in 1861, and is decidedly his masterpiece, though it has not attained the popularity, with the general reader, of some of his more melodramatic novels. Among the more important of his other works are: 'Love Me Little, Love Me Long' (1859); 'Hard Cash' (1863); 'Griffith Gaunt' (1866); 'Foul Play' (with Dion Boucicault, 1869); 'Put Yourself in His Place' (1870); 'A Terrible Temptation' (1871); 'The Wandering Heir' (1872); 'A Perilous Secret' (1884). He was also the author, either alone or in collaboration with others, of several dramas, including 'Gold'; 'Two Loves and a Life'; 'The King's Rivals'; and 'Drink,' the last adapted from Zola's 'L'Assommoir.' None of these won much success for Reade. His 'Courier of Lyons,' renamed 'The Lyons Mail,' has been made famous by Sir Henry Irving in the dual role of Lesurques and Dubosc. Reade was enthusiastic by nature, and continually filled with new enthusiasms toward any cause which roused his easily excited interest. The abuses in the convict prison system produced, as was said, one of his best-known novels; the system of private lunatic asylums furnished the motive for 'Hard Cash,' as the trades-union outrages at Sheffield did for 'Put Yourself in His Place,' while in 'Foul Play' he attacked the alleged practice of overloading and over-insuring ships. His writings show considerable skill in the delineation of character, much narrative, descriptive, and dramatic power, combined at times with coarseness and theatricality. He may, perhaps, be said to rank first in the second order of English novelists of the 19th century, and was as popular in this country as in his own. Consult: Swinburne's article in his 'Miscellanies' (1886); 'Charles Reade: A Memoir' (1887); Ireland, 'Extracts,' with an introduction (1891); and the 'Gentleman's Magazine' for 1882.

Reade, John, Canadian Anglican clergyman and journalist: b. Ballyshannon, Ireland, 13 Nov. 1837. He was educated at Queen's College, Belfast, and in 1856 went to Canada, where he founded the Montreal 'Literary Magazine,' and was also connected with the Montreal 'Gazette.' He engaged in teaching, practised law at intervals, and in 1864 took orders in the Church of England. In 1887 he was elected president of the Montreal Society for Historical Studies. He wrote: 'The Prophecy and Other Poems' (1870); 'Language and Conquest' (1883); 'The Making of Canada' (1885); 'Vita sine Liberis' (1886); 'Aboriginal American Poetry' (1887); etc.

Reade, William Winwood, English traveler and novelist, nephew of Charles Reade (q.v.): b. Ipsden, Oxfordshire, 30 Jan. 1838; d. Wimbledon, Surrey, 24 April 1875. He visited the western coast of Africa in 1862, and in 1868 started from Sierra Leone and reached the source of the Niger. He was special correspondent for the London *Times* in the Ashantee war, 1873-4. Of his literary work perhaps his most notable effort is 'The Martyrdom of Man' (1872), a history of human slavery. His other works include 'The Veil of Isis' (1861); 'Savage Africa' (1863); 'The African Sketch Book' (1873); 'Story of the Ashantee Campaign' (1875); 'The Outcast' (1875); etc.

Read'er, Francis Smith, American journalist: b. Coal Centre, Pa., 17 Nov. 1842. He was connected with the United States Civil Service for 10 years, and served with the Union army thoughout the Civil War. Later he became editor of the Beaver Valley 'News.' He published 'Life of Moody and Sankey' (1890); 'History of the 5th West Virginia Cavalry' (1890); 'History of New Brighton, Pa.' (1899).

Reader. See ORDERS, HOLY.

Reading, rĕd'ĭng, England, capital of the county of Berkshire, 28 miles southeast of Oxford. It has handsome municipal buildings; a public hall, and free library; a museum, and excellent schools. There are remains of the magnificent Benedictine Abbey founded by Henry I., in which he was buried. Henry VIII. converted the castle into a palace; later it was destroyed during the Cromwellian wars, and the gateway alone has been restored. Other churches are St. Mary's, rebuilt from a nunnery founded by Elfrida to expiate the murder of her stepson (Edward the Martyr); St. Lawrence (Norman), rebuilt in the 15th century; St. Giles' (mixed architecture), and Greyfriars Church. Reading was the headquarters of the Danes in 871; was a refuge for the students who defied the Parliament; for the law courts obliged to leave London to escape the terrible plague, and was the fighting ground of rival armies during the conflicts of the rebellion. Reading is the centre of a large agricultural district, has an active trade and various important industrial establishments.

Reading, Mass., town in Middlesex County, on the Boston & Maine railroad, about 10 miles north of Boston. It was settled in 1638, and six years later was incorporated. It is a beautiful residential town, and has considerable manufacturing interests. The chief manufactured products are imitation leather, wire brushes, boots and shoes, rubber and rubber goods, games, church organs and organ pipes, toys, and furniture. The public library contains nearly 10,000 volumes. The government is administered by town meetings, which convene annually. Pop. (1890) 4,088; (1900) 4,969; (1910) 5,818.

Reading, Pa., city, county-seat of Berks County; on the Schuylkill River and the Schuylkill Canal, and on the Pennsylvania, the Wilmington & Northern, and the Philadelphia & Reading R.R.'s; about 58 miles northwest of Philadelphia, and 55 miles east by north of Harrisburg. Its area is about six square miles. Reading was first settled by Germans, but later a number of English colonists located there, and named the place after Reading in England. In 1748 it was laid out, and in 1783 was incorporated as a borough. It was chartered as a city in 1847. It is in an agricultural region, in which there is great mineral wealth. It has extensive manufacturing and commercial interests. East of the city is Mount Penn, and south of it is Neversink Mountain. Inclined and electric railways extend to the summit of both mountains. Mount Penn is 1,140 feet above sea-level, and on its top is a stone tower 50 feet high. The chief industries are connected with iron and steel productions, but the coal mines and limestone quarries contribute to the industrial wealth of the city. The chief industrial establishments are railroad shops, machine shops, foundries, potteries, paper and wood pulp mills, breweries, knitting mills, hosiery mills, hat factories, carriage works, cigar factories, and iron and steel works. The capital invested in manufacturing in 1900 (Federal census) was $27,975,628, and the average annual output was valued at $36,902,511. The iron and steel industries had the largest invested capital and about one fourth of the output. There were, in 1900, over 500 manufacturing establishments, representing about 100 different industries. The principal public buildings of Reading are the government building, the county court-house, city-hall, opera house, Masonic Temple, the churches and schools. The charitable institutions are Saint Catherine's Orphan Asylum (girls), city and county orphanages, House of the Good Shepherd, Saint Joseph's, the Reading, and the Homœopathic hospitals. The educational institutions are the Schuylkill Seminary, the Inter-State Commerical College, Mount Saint Michael's Academy, Reading Classical School, Reading Academy and Business College, two high schools, a number of private schools, and two school libraries.

The city has an excellent park system covering in all nearly 200 acres. The government is vested in a mayor, who holds office three years, and a council. The members of the board of education are chosen by popular election. The annual municipal expenditures for maintenance and operation are about $930,000; the chief items being, for schools, $257,000; for the water department, $234,500; for the police department, $53,200; for municipal lighting, $60,000; for streets, $60,000, and for fire department, $35,000. The waterworks cost the city originally $1,937,762. They are owned and operated by the municipality. In 1867 and 1869 the city boundaries were enlarged. Pop. (1783), when it became a borough, 2,100; (1847), when chartered, 12,000; (1900), 78,961; (1910) 96,071.

Readjusters, or **Refunders,** the name of a political party in Virginia, which passed several bills providing for the scaling and partial rejection of the public debt of the State. Virginia, at the close of the Civil War, was greatly impoverished, burdened with a large indebtedness, and shorn of part of its territory, which had been erected into the State of West Virginia. The reconstruction government added considerably to the debt, and a keen controversy arose over the question of meeting the obligations. An act passed in the legislative session of 1870–71 to refund the debt was repealed, but the repeal was declared unconstitutional by the courts. In 1878 the Legislature passed a measure known as the McCulloch bill, which provided for new bonds, to be exchanged at par for outstanding bonds, and to bear interest at 3 per cent for 10 years, 4 per cent for the following 20 years, and 5 per cent for 10 years, when the principal would fall due. This act did not satisfy those opposed to payment of the debt in full, who became known as «Readjusters,» and included in their ranks both Democrats and Republicans. Under the leadership of H. H. Riddleberger they succeeded in getting control of the Legislature, and passed a bill scaling the debt from $31,102,571 to $19,665,196. This bill was vetoed by the Governor. In 1881 the Readjusters obtained complete control of the State, and laws were enacted in accordance with their policy, the same course being pursued in 1884, 1886, and 1887. The United States Supreme Court delivered nine opinions declaring the readjustment measures, so far as they prohibited the receipt of State bond coupons for taxes, as provided by the McCulloch law, to be in conflict with the provision of the Federal Constitution, upholding the obligation of contracts. The State could not be coerced into payment, and matters remained unsettled until a compromise was agreed upon between the State and holders of the bonds.

Reagan, rē'gan, **John Henninger,** American politician: b. Sevier County, Tenn., 8 Oct. 1818; d. Palestine, Texas, 6 Mar. 1905. At 21 he settled in Texas, where he practised law and was a member of the Texas Legislature in 1847. In 1856 he was elected judge of the district court, but resigned the next year to go to Congress, of which he remained a member until 1861. During the Civil War he served as postmaster-general of the Confederate States, and acting secretary of the Confederate Treasury. He was a member of the Texas Constitutional Convention 1875, member of the Congress 1875–97, United States Senator 1887–91, and afterward chairman of the Texas State Railroad Commission. He introduced the «Reagan Inter-State Commerce Bill,» on which the present interstate commerce legislation is based.

Real, rē'al, a Spanish coin, the old unit of value in Spain. By the monetary law of June 1864, the silver real was made to weigh 1.298 grams, .81 fine, and equivalent to 4½ cents. It has varied in value from 4½ to 10 cents.

Real Presence, the doctrine of the actual presence of the body and blood of Christ in the Eucharist. See CONSUBSTANTIATION; EUCHARIST; MASS; TRANSUBSTANTIATION.

Real Variable, Theory of Functions of the; a mathematical science. A variable is a symbol (such as x or y or «time» or «temperature») which stands for any member of a class of things. A particular member of the class is called a «value» of the variable which is said to «take on» its values. One variable, y, is said to be a single-valued function of another variable, x, if to every value of x there corresponds one and only one value of y. This is the case, for example, if x stands for any number and $y=x^2$. It is customary to express such a relation between y and x by the equation $y=f(x)$; x is called the independent and y the dependent variable. If the restriction that *only one* value of y shall correspond to each value of x is removed, y is called a multiple-valued function of x. Unless otherwise provided, the word function in the following pages shall mean single-valued function.

While the notions of variable and function as thus defined apply to any class of objects whatever, they are usually thought of only in connection with classes of numbers. In fact the phrase Theory of Functions is at present understood by mathematicians to mean either the theory of functions of a complex variable (*q.v.*) or the theory of functions of a real variable. In a certain abstract sense, the theory of the complex variable might be supposed to include the theory of the real variable, since all values of the real variable x_1 are included as special values ($x_2=0$) of the complex variable $x_1+x_2\sqrt{-1}$. As matter of fact, however, the theory of functions of a complex variable has yet concerned itself but little except with analytic functions, *i.e.*, those functions which may be thought of as defined by a power-series together with its continuations. This theory therefore leaves untouched the widest class of functions of the real variable. On the other hand, since the theory of functions of a complex variable gives a broader and hence more unified theory of analytic functions than can be furnished by the real function theory, these functions are not ordinarily given special attention in the latter theory. For a discussion of algebraic functions the reader is referred to the article on Algebra; for transcendental functions, *i.e.*, functions which are not algebraic, see TRIGONOMETRY, HARMONIC ANALYSIS, DIFFERENTIAL EQUATIONS, SERIES etc.

The theory of functions of a real variable is a product of the critical tendency of mathematics in the latter half of the nineteenth century. It has yielded comparatively few new theorems about the functions hitherto studied in applied mathematics, and has therefore had less influence on these sciences than has the complex variable theory. Its main business has been the restatement in rigorous form and with proper limitation of generality, the brilliant though sometimes inexact theorems won by the earlier students of infinitesimal calculus. For example, the study of vibrating strings, membranes, etc., and of the conduction of heat led to the celebrated trigonometric series of J. B. J. Fourier (*q.v.*), which was at first incorrectly supposed to furnish a method of representing an arbitrary function. The reconsideration of this series and the attempt to determine exactly what functions are expansible by trigonometric series has led to many of the most abstruse theorems about point-sets. The theory of point-sets (Punktmengen, 'Assemblages of Points'; see article ASSEMBLAGES, GENERAL THEORY OF), it should be remarked in explanation of the proportionately large space allotted to it below, is the most characteristic feature of real function theory.

The Real Variable.—The real numbers are, first, the whole numbers positive and negative; second, the rational fractions of the form m/n where m and n are whole numbers, and, third, the irrational numbers such as $\sqrt{2}$ and π. On this subject, see the articles on Arithmetic and Algebra, and the Bibliography[8] at the end of this sketch. (Reference numbers such as that on the word Bibliography correspond to the numbers attached to works in the Bibliography.)

The totality of real numbers is a field (Kőrper), *i.e.*, a set of elements upon which can be performed the operations of addition and multiplication, according to the well-known rules.[8] We suppose also known the derived operations of subtraction, division, and raising to a power. A special symbol is used to distinguish the numerical from the algebraic value of a number: if x is positive, $|x| = x$, if x is negative, $-|x| = x$. The relation of geater and less is indicated by the symbols $<$, $>$; $a > b$ means a is greater than b, $a < b$ means a is less than b. Considerable attention has been given to the problem of stating explicitly the hypotheses of the real number system. We state here only that one the discussion of which has had the most far-reaching consequences.

Principle of Continuity.—If $[x]$ is any set of real numbers all less than a certain number, b, then there is a number, $\bar{x}$, such that every number of $[x]$ is less than or equal to $\bar{x}$, and such that $\bar{x}$ is the smallest number of which this is true. In other words, $x \leqq x$ for every x of $[x]$, and if $a < \bar{x}$, there is a number x' of $[x]$ such that $a < x'$.

Any number, such as b in the statement above, which is larger than every number of a set $[x]$ is called an upper bound of $[x]$; a number smaller than every number of a set $[x]$ is called a lower bound of $[x]$. In this language the principle of continuity says that every set having any upper bound has a least upper bound. It follows immediately that every set having a lower bound has a greatest lower bound. The greatest lower bound or least upper bound of a set may or may not belong to the set. Thus, zero is the greatest lower bound of the set of all positive numbers but does not belong to it; on the other hand, zero is the least upper bound and does belong to the set of all real numbers which are not positive.

A very large proportion of the advances in critical sharpness of the modern analysts over those of the seventeenth and eighteenth centuries is due to the recognition of places where the earlier analysts had unconsciously assumed, or had neglected to apply, the principle of continuity. The form in which this postulate is here stated is due to K. Weierstrass[1, 2]. Other forms have been given by R. Dedekind[3] and G. Cantor[4]. Indeed, the theory of continuity and irrational numbers is due about equally to these three great Germans.

Segment, Interval, Limit Point. — By the method of analytic geomerty (*q.v.*) there is a correspondence between the totality of real numbers and the points of a line; likewise between the set of all pairs of numbers (x, y) and the points of a plane, the pair (x, y) corresponding to the point of which x and y are the coördinates. On account of this correspondence, it is customary to use geometrical language in the theory of real functions; thus, the word point is used interchangeably with the word number. A linear segment is the set of all numbers x, $a < x < b$, or the set of all points between a and b; a planar segment is the interior of a parallelogram with sides parallel to the coördinate axes, or the set of all number-pairs (x, y), $a < x < b$, $c < y < d$. The word interval is used for a segment *plus* its boundaries, *i.e.*, $<$ is replaced by $\leqq$ in the definition just given. A segment, linear or planar as the case may be, including a point, is called a neighborhood of the point.

Among the most important consequences of the principle of continuity is the following theorem which was first stated in a slightly different form by E. Borel[11] in 1895. Since its method is essentially involved in the proof of the theorem of uniform continuity (see below) given by E. Heine[5] in 1871, it is usually called (after A. Schoenflies[6]) the Heine-Borel theorem: Every set of segments $[\sigma]$ such that every point of an interval, i, is an interior point of at least one σ, has a finite subset $\sigma_1, \sigma_2, \ldots, \sigma_n$, such that every point of i is an interior point of at least one σ_k $(k = 1, 2, \ldots, n)$.[9]

We shall prove this theorem only for the linear case, the proof of the planar case being quite analogous. Let the end points of the interval i be a and b, $a < b$. Let $[b']$ be a set including every point, b', of i such that the interval ab' is contained in a finite number of segments of $[\sigma]$. There is at least one b'; for one of the end points of any segment of $[\sigma]$ which includes a is evidently a point of $[b']$. By the principle of continuity, the set of all points, $[b']$, has a least upper bound B; $B \leqq b$. We shall prove that B is a point of $[b']$ and that $B = b$.

Let $a''b''$, $a'' < b''$, be a segment of $[\sigma]$ including B. Since B is the least upper bound of $[b']$ there is a point of $[b']$, b_1' between a'' and B. But if $\sigma_1, \sigma_2, \ldots, \sigma_e$ is the finite set of segments including all points of the interval ab_1', this set together with $a''b''$ will include B, which proves that B is a point of $[b']$. Moreover, if $B < b$, the set $\sigma_1, \sigma_2, \ldots, \sigma_e$ together with $a''b''$ would include every point of an interval ac, c being a point between B and b''. c would therefore be a point of $[b']$ contrary to the hypothesis that B is an upper bound of $[b']$. Hence $B = b$ and the Heine-Borel theorem is proved.

A point a in every neighborhood of which there are points, distinct from a, of a set $[x]$ is a limit point of $[x]$; a either may or may not be a point of the set $[x]$. If $[x]$ is a linear set, a is either the greatest lower bound of the numbers of $[x]$ greater than it or the least upper bound of the numbers of $[x]$ smaller than it. A linear point-set without an upper bound is said to have the limit point $+\infty$ and one without a lower bound to have the limit point $-\infty$. The following theorem of Weierstrass is a simple corollary of the Heine-Borel theorem.

“Every infinite set of points lying on an interval has at least one limit point.” If it had no limit point, then about every point of i there would be a segment including not more than one point of $[x]$. This set of segments, by the Heine-Borel theorem, would have a finite subset including all the points of i. But each interval of the subset not containing more than one point of $[x]$, $[x]$ could contain at most a finite number of points, contrary to hypothesis.

If $[x]$ is a linear point-set, and if we allow $+\infty$ and $-\infty$ to figure as limit points, the theorem may, of course, be modified to read: every infinite linear point-set has at least one limit point.

Theory of Linear Point-sets.—The set of limit points of a set $[x]$ is called the first derived set of $[x]$. The first derived set of the first derived set is the second derived set, etc. The theory of successive derived sets has been highly developed by the aid of the transfinite numbers of Cantor[4] (see ASSEMBLAGES). A set which includes its first derived set is said to be *closed* (*abgeschlossene*). A set included in its derived set is *dense in itself* (*insichdicht*). A set which is the same as its first derived set, *i.e.*, which is both closed and dense in itself, is said to be *perfect*. An example of a set closed but not dense in itself is furnished by the number 0, together with the numbers $\frac{1}{2^n}$ $(n = 1, 2, 3, \ldots)$. A set dense in itself but not closed is the set of all rational numbers. The set of all numbers is an example of a perfect set.

A set whose derived set is the set of all real numbers on a certain interval is *everywhere dense* (*überalldicht*) on this interval. Such a set has a point between every two points of the interval. A set which is everwhere-dense on no interval is nowhere dense. The first of the examples above is a nowhere-dense set, the second and third are everywhere-dense sets.

If $[x]$ is a closed set, nowhere dense on an interval ab, and c any point of ab not in $[x]$, then there is a segment, including c, whose end points belong to $[x]$, but which contains no point of $[x]$. Such a segment is called a point-free segment of $[x]$. Thus, for every closed set $[x]$ there exists one, and only one, set of point-free segments. No two of these segments overlap. Therefore they are an enumerable (or denumerable) set (see ASSEMBLAGES), namely, there can be only a finite number of length $\geqq \frac{b-a}{2}$, a finite number of length $\geqq \frac{b-a}{4}$, and in general only a finite number of length $\geqq \frac{b-a}{2^n}$. The set $[s]$ of end points and limit points of end points of the point-free segments is evidently a closed set and is identical with $[x]$. Since the set of point-free segments is enumerable, its end points are enumerable and thus the nowhere-dense closed set is the derived set of an enumerable set of points. A consequence of this which we do not stop to prove here is that there is a one-to-one correspondence between the continuum and any perfect subset of itself; the argument depends on the theory of point-free segments and the fact that the continuum is the derived set of the enumerable set of all rational numbers.[6]

The notion, length of an interval, finds a generalization in the *content* of a point-set. $[x]$ being any set of points on an interval i, let $\sigma_1, \sigma_2, \ldots, \sigma_n$ be any finite set of intervals of length $l_1, l_2, \ldots, l_n$, including every point of $[x]$. Let $L = l_1 + l_2 + \ldots + l_n$. There are, of course, an infinity of numbers, L. Their greatest lower bound is called the content of $[x]$ and written $c[x]$. If $[x]$ is a closed set and S is the sum of the finite or infinite series obtained by taking the lengths of the point-free segments in the order of their magnitude, we have $c[x] = l - S$, where l is the length of the interval i. Thus in the case of a closed set $[x]$ and its complementary set $[\bar{x}]$, which consists of all points of the interval not points of $[x]$, we have $c[x] + c[\bar{x}] = l$.[6] This, however, is not true of sets in general. For example, the set of all rational numbers between 0 and 1 has the content unity and the set of all irrational numbers on the same interval has the same content. The notion of length is therefore extended by the definition of content, only to closed sets and not to sets in general. A much more far-reaching generalization of length has, however, been suggested by E. Borel[11] and carried out by H. Lebesgue[12] in connection with the theory of definite integrals (see below).

Functions Defined on an Interval.—On account of the generality of the definition, practically no theorems are known which apply to all functions on a given interval. One of the most general theorems known is obtained by introducing the restriction that on a certain interval, $f(x)$ shall have an upper bound. By this it is meant that there shall be a number, B, such that for every x on the given interval $f(x) \leqq B$. From the principle of continuity it is clear that a function having an upper bound upon an interval, i, has a least upper bound B_0, and by aid of the Heine-Borel theorem, it is easily proved that there is at least one point, x_1, on the interval, such that for every interval of i

which includes x_1, B_0 is the least upper bound of $f(x)$. This is a theorem of Weierstrass.[1]

Another broad class of functions is that of the monotonic functions.[1] A function, $f(x)$, is monotonic increasing if whenever $x_1 < x_2$, $f(x_1) < f(x_2)$; it is monotonic deereasing if whenever $x_1 < x_2$, $f(x_1) > f(x_2)$. In the case of a monotonic function, $f(x)$, not only is there a single value of $y = f(x)$ for every value of x, but for every value of y taken on by $f(x)$ there is one and only one value of x. In this case it is the custom to write $x = f^{-1}(y)$ and to call $f^{-1}(y)$ the inverse function of $f(x)$. Thus every monotonic function, $f(x)$, has a single valued inverse which, however, is not necessarily defined for all values of y.

In antithesis to the monotonic functions stand oscillating functions, those such that on the interval under consideration there are three values of the independent variable, x_1, x_2, x_3, $x_1 < x_2$, $x_2 < x_3$, such that $f(x_1) < f(x_2)$, $f(x_2) > f(x_3)$, or $f(x_1) > f(x_2)$, $f(x_2) < f(x_3)$. There exist functions which oscillate on every interval; indeed, a function may oscillate on every interval and still be continuous and have a continuous derivative.[6] The definition of continuity is given below and of derivation in the article CALCULUS. In most investigations hitherto the functions considered have had only a finite number of oscillations; *i.e.*, there would exist a finite set of points such that on the intervals between successive points the function would not oscillate. It is to be noted that a non-oscillating function is not necessarily monotonic; there may be intervals upon which it is a constant.

The word oscillation is also used to denote a measure of the total amount of variation of a function on a given interval, that is, the difference between the upper and lower bounds of $f(x)$. This is a satisfactory measure in case $f(x)$ is monotonic. In other cases, especially in case of functions with oscillation on every interval, this scheme is naturally extended as follows: Let $x_1, x_2, x_3, \ldots, x_{n-1}$ be any finite set of points on the interval ab in the order $a < x_1 < x_2 < x_3 \ldots < x_{n-1} < b$. Calling $a = x_0$ and $b = x_n$, we have $\sum\limits_{\kappa=1}^{n}(f(x_\kappa) - f(x_{\kappa-\delta})) = f(b) - f(a)$. But $\sum\limits_{\kappa=1}^{n}|f(x_\kappa) - f(x_{\kappa-1})| = R$ is, except for non-oscillating functions, different from $f(b) - f(a)$. For every finite set of points $x_1, x_2, \ldots, x_{n-1}$, there is a value of R. The least upper bound, V, of the set of all possible numbers, R, is called the *variation* of $f(x)$ on the interval ab. A function for which V is finite is called a function of limited variation; such a function can always be expressed as the difference between two monotonic functions. Functions of limited variation were first defined and studied by C. Jordan in connection with the theory of lengths of curves.

Theory of Limits. — Turning from the description of a function by its properties on an interval to a consideration of its appearance in the immediate neighborhood of a point, we are led to consider the notions of limits and of continuity. If a is a limit point of a set of points $[x]$, then the variable x is said to approach a on the set $[x]$. In case all the values of x are $\geqq a$, the approach is said to be from above, and in the opposite case, from below. Let $f(x)$ be a function which is defined and bounded on an interval ab, $a < b$, and let $x_1, x_2, \ldots$ be any set of points of ab of which a is the only limit point. Such a set is, for example,

$$a + \frac{b-a}{2},\quad a + \frac{b-a}{4}, \ldots a + \frac{b-a}{n} \ldots$$

The points whose coördinates are $(x_1, f(x_1))$, $(x_2, f(x_2))$, etc., in the graphical representation of $f(x)$ are a bounded set in the plane, and therefore have at least one limit point. The x coördinate of this point cannot be other than a, since every other x coördinate may be surrounded by a segment including at most one point of the set, $x_1, x_2, \ldots$. Call the y coördinate of this point, y_0. The value y_0 is such that for every pair of positive numbers, ϵ and δ, there is a value of $x > a$, such that $|x - a| < \delta$ and $|f(x) - y_0| < \epsilon$. A number, y_0, satisfying this condition is called a value approached by $f(x)$ as x approaches a from above. If in every interval $a\bar{x}$ of ab, $f(x)$ is without an upper bound, $f(x)$ is said to approach the value $+\infty$ as x approaches a from above; if $f(x)$ is without a lower bound in every interval $a\bar{x}$, $f(x)$ approaches $-\infty$. Thus we have the highly important theorem that as x approaches any finite value from above (and by parity of reasoning, from below) $f(x)$ approaches at least one value, finite or infinite.

A finite value approached by $f(x)$ as x approaches $+\infty$ is a number, y_0, such that for every pair of positive numbers, ϵ and δ, there is a value of x such that $x > \delta$ and $|f(x) - y_0| < \epsilon$. $f(x)$ approaches $+\infty$ as x approaches $+\infty$ if, for every ϵ and δ, there is a value of x such that $x > \delta$ and $f(x) > \epsilon$. The definition of approach to $-\infty$ is analogous. In the case where x approaches a finite value, x_0, from above or below or from both sides, $f(x)$ approaches y_0 if for every pair of positive numbers, ϵ and δ, there is a value of x $(x \neq x_0)$, such that $|x - x_0| < \delta$ and $|f(x) - f(x_0)| < \epsilon$. The theorem of the last paragraph now extends to all cases: if x approaches any value finite or infinite, $f(x)$ approaches *at least one value*, finite or infinite.

If $f(x)$ approaches only one value as x approaches a, the value approached is said to be the limit of $f(x)$ (or limiting value of $f(x)$) as x approaches a, and is indicated by the symbol $\underset{x=a}{L}f(x)$ or simply $Lf(x)$. If $L(fx) = f(a)$ the function $f(x)$ is said to be continuous at the point $x = a$. A necessary and sufficient condition for the existence of the equality $Lf(x) = b$ is the following: for every $\epsilon > 0$ there exists a $\delta_\epsilon > 0$, such that for *every* $x \pm a$ for which $|x - a| < \delta_\epsilon$, $|f(x) - b| < \epsilon$. This condition, which is frequently taken as the definition of a limit,[6,7] has to be appropriately modified in the cases where a and b are replaced by $+\infty$ or $-\infty$. The following is a necessary and sufficient condition that $Lf(x)$ shall exist and be finite:[1,8] for every $\epsilon > 0$ there exists a $\delta_\epsilon > 0$, such that for x' and x'' distinct from a and such that $|x' - a| < \delta_\epsilon$ and $|x'' - a| < \delta_\epsilon$, $|f(x') - f(x'')| < \epsilon$.

The proof of these necessary and sufficient conditions and also of the following theorems must be omitted for lack of space. If $f_1(x)$ and $f_2(x)$ approach definite limiting values as x approaches a, then $f_1(x) + f_2(x)$, $f_1(x) - f_2(x)$, and $f_1(x) \cdot f_2(x)$ approach $Lf_1(x) + Lf_2(x)$, $Lf_1(x) - Lf_2(x)$, and $Lf_1(x) \cdot Lf_2(x)$ respectively, as x approaches a; if $Lf_2(x) \neq 0$, then $f_1(x)/f_2(x)$ approaches $Lf_1(x)/Lf_2(x)$. These propositions are evidently to be thought of also as propositions about continuous functions. To them should be added the statement that if $f_1(x)$ is continuous at $x=a$ and $f_2(y)$ is continuous at $y=f(a)$, then $f_2(f_1(x))$ is continuous at $x=a$. Also, if $f(x)$ is continuous at a point $x=a$, and if $f(a)$ is positive, then there is a neighborhood of $x=a$ upon which the function is positive.[1]

In the above propositions about limits it is not necessary that $f(x)$ be defined at every point of an interval. Everything we have said about $Lf(x)$ remains valid when x takes values on any set of which a is a limit point. Indeed, in one of the most important cases, that of the summation of series (*q.v.*) the independent variable takes on only integral values, and $a=+\infty$. For the following theorems, however, we assume that $f(x)$ is defined at every point of an interval.

Continuous Functions.—$f(x)$ is continuous on an interval ab if it is continuous at every point of the interval; in particular, it must be continuous at a and b. One of the most famous propositions of real function theory states the principle of uniform continuity:[5] if ϵ is any positive number, there is a $\delta_\epsilon > 0$, such that on every interval of ab of length less than δ_ϵ the oscillation of $f(x)$ is less than ϵ. Other propositions in this connection are that a continuous function has a finite maximum value $f(x_1)$ and a finite minimum value $f(x_2)$ and takes on all intermediate values.[6] An important corollary of this is that every algebraic equation of odd degree with real coefficients has one real root. If a function is monotonic and continuous, it has a monotonic and continuous inverse.

If $f_1(x)$ and $f_2(x)$ are continuous on an interval ab and if $f_1(x)=f_2(x)$ on a set everywhere dense on ab, then $f_1(x)=f_2(x)$ at every point of the interval ab. The last theorem enables us to say that if a continuous function is known at every point of an everywhere dense subset of an interval, it is known on the whole interval. Since there are enumerable everywhere dense subsets, a continuous function is thus capable of determination by an enumerable set of conditions. This phenomenon is also manifested in the theorem that any continuous function may be expressed as a convergent series of polynomials. Generalizations of this theorem to discontinuous functions have been obtained by R. Baire,[13] the next class of functions beyond the continuous being those discontinuous functions which are representable by series of continuous functions.

The class of continuous functions includes as a subclass the differentiable functions, *i.e.*, those continuous functions which possess at every point a derivative (see CALCULUS). The existence of a derivative, which amounts to the condition that the graph of $f(x)$ shall possess a tangent, puts a limitation on the manner in which a function may oscillate.[7] The earlier students of calculus assumed that every continuous function may be differentiated, in fact, several proofs of this statement were offered. Weierstrass[8] was the first to give an example of a function which is everywhere continuous and such that for no interval is it differentiable at every point.

A subclass of the differentiable functions is constituted by those functions for which the second, third, and in general the nth derivatives exist. For such a function a formal expansion by means of Taylor's formula (cf. SERIES, CALCULUS) is always possible, but as has been shown by A. Cauchy and A. Pringsheim,[9] this series need not always converge and, if convergent, need not represent the function. A function which may be represented by Taylor's series is called analytic. Necessary and sufficient conditions for the expansibility of functions by Taylor's series have been given by Pringsheim, but the full significance of the existence of all the derivatives of a continuous function is still to be determined.

Another outstanding problem in connection with continuous functions is that of the orders of infinites and infinitesimals. A function $f(x)$ becomes infinite or infinitesimal at a point if it approaches $+\infty$, $-\infty$, or 0. If $f(x)$ and $\phi(x)$ both become infinite (or infinitesimal) at the same point, a, we may have their quotient approaching (1) more than one limit, (2) a unique finite limit, not zero, (3) zero, (4) $+\infty$. For the first case no extensive theory has been developed. In the second case the functions are said to be of the same order; in the third case $f(x)$ has an infinity of lower order or is infinitesimal of higher order than $\phi(x)$; in the fourth case $f(x)$ has an infinity of higher order or is infinitesimal of lower order than $\phi(x)$. For analytic functions the notion of order is well established, for other functions not.

Discontinuous Functions.—A function may fail to be continuous at a point in several ways. In the first case, $Lf(x)$ may exist but be different from $f(a)$. In this case the discontinuity is called removable (*hebbare*), because by modifying the value of $f(a)$ to be the same as $Lf(x)$ a continuous function is obtained. If $Lf(x)$ fails to exist, $f(x)$ may still approach definite limits from above and from below. These limits are usually indicated by $f(a+0)$ and $f(a-0)$. $f(a)$ may coincide with either of them or differ from both. All these cases are referred to as discontinuities of the first kind.[1] If $f(a+0)$ or $f(a-0)$ fails to exist, that is, if $f(x)$ approaches more than one value as x approaches a from the right or from the left, $f(x)$ is said to have a discontinuity of the second kind at $x=a$. For this to occur, $f(x)$ must have an infinity of oscillations in every neighborhood of $x=a$. Such a function is $\sin\left(\frac{1}{x}\right)$ in the neighborhood of $x=0$.

It is easily provable that there is a finite or infinite greatest value approached by $f(x)$ on either side of $x=a$ and likewise a finite or infinite least value approached. These four numbers are generally denoted by $\overline{f}(a+0)$, $\overline{f}(a-0)$, $\underline{f}(a+0)$, $\underline{f}(a-0)$. The differences among these four numbers and $f(a)$ give a variety of ways of defining a measure of the amount of discontinuity at a point. For example, the lower bound of the oscillation of $f(x)$ on every interval which includes $x=a$ is the difference between the greatest and the least of these five numbers and is called the oscillation of $f(x)$ *at* $x=a$.

In classifying discontinuous functions according to the distribution of the points of discontinuity over an interval there are two cases of which other cases are compounds. On the one hand, are the totally discontinuous functions, *i.e.*, functions discontinuous at every point, such, for example, as the function which is $+1$ if x is a rational number and -1 if x is an irrational number. On the other hand, every interval may contain a point where $f(x)$ is continuous; such a function is called point-wise discontinuous, though there is some divergence of usage in this particular.[1] A point-wise discontinuous function has the property that the points where the oscillation is greater than any fixed positive number, ϵ, constitute a nowhere-dense closed set. On considering an infinite sequence, $\epsilon, \frac{\epsilon}{2}, \frac{\epsilon}{4}, \ldots$ of such numbers, it is evident that the set of points of discontinuity of a point-wise discontinuous function is an enumerable set of nowhere-dense closed sets.

The theory of discontiuous functions has received perhaps its main impetus from the study of definite integrals (see CALCULUS). It is easily seen by aid of the principle of uniform continuity that every continuous function is integrable and it is also evident that a totally discontinuous function is not integrable. Riemann proved that a necessary and sufficient condition for the integrability of a discontinuous function is that the set of points at which the oscillation of $f(x)$ is greater than any positive number shall be of content zero.' Thus an integrable function is continuous or so point-wise discontinuous that the set of points of discontinuity is an enumerable set of sets of content zero.

The content of a point-set is the definite integral of a function which is equal to unity for all points of the set and to zero for all other points. Corresponding to the Borel-Lebesgue generalization of content is a generalization of the definite integral, due to Lebesgue,[12] which extends the notion to a very broad class of functions. This generalization has been guided largely by the aim to state the definitions of differentiation and integration in such a way that they shall be inverse operations. According to the usual definitions (see CALCULUS) this is true for a limited class of functions, but there exist, on the one hand, functions whose integrals cannot be differentiated, and, on the other hand, functions whose derivatives cannot be integrated. The only effective generalization of the derivative that has been suggested in this connection is the substitution for the regular limit of $[f(x)-f(x_1)]/[x-x_1]$, one of the upper and lower bounds of the values approached by it as x approaches x_1 from above or below.

Attempts to generalize the limiting process in various directions are characteristic of the present tendencies in analysis. The principal results so far have been obtained in connection with infinite divergent series by Cesaro, Mittag-Leffler, Borel,[13] and others. Another class of problems is the solution of functional equations. For example, it is known that among continuous functions, if $f(x+y)=f(x)+f(y)$, then $f(x)=ax+b$. But is this true if the restriction of continuity be removed?

Functions of More than One Variable.—The above account has dealt entirely with functions of one variable. A single-valued function of several variables, $f(x_1\,x_2 \ldots x_n)$ is a variable y such that to every set of values $(x_1, x_2, \ldots, x_n)$ there corresponds one, and only one, value of y. The theory of such functions differs from that which we have been considering mainly in that the point-sets involved are no longer linear, but, rather, n dimensional. The approach to a point in a limiting process may now take place not only from two sides but by an infinity of paths. In grasping this situation, the principal idea so far advanced is that of uniform convergence (cf. SERIES). But on this subject the reader is referred to the treatises cited below.

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Realf, rălf, **Richard,** Anglo-American poet: b. Framfield, Sussex, 14 June 1834; d. Oakland, Cal., 28 Oct. 1878. He published a volume of verse, 'Guesses at the Beautiful,' when 18; came to the United States in 1854, settling in Kansas, and, becoming a follower of John Brown, enlisted in the Union army in 1862, and wrote some of his best poetry in the field. Among his best-known poems are 'My Slain' and 'Indirection.' A collection of his poems was edited by R. J. Hinton (1899).

Realgar, a gorgeous, aurora-red mineral, found massive and in transparent or translucent, monoclinic crystals of short prismatic habit. Its lustre is resinous, hardness 1.5 to 2; streak orange-red. Analysis shows that it contains sulphur 29.9, arsenic 70.1, yielding the formula AsS or arsenic monosulphide, though it is usually regarded as arsenic disulphide, As_2S_2. Upon exposure to light it soon disintegrates, changing to a pulverulent, orange-yellow orpiment (As_2S_3) and white arsenolite (As_2O_3). Several localities in Hungary and neighboring countries are of commerical as well as mineralogical importance. It has recently been discovered in Macedonia, at Mercur in Utah, and massive, in enormous deposts, in the State of Washington. Its previous rarity precluded its use in the manufacture of an senious oxide, for which purpose it is now extensively mined in Washington. Artificial realgar, known as «red orpiment» or «ruby sulphur,» when mixed with nitre forms «white Indian fire.»

Realism, (1) a term used in two fundamentally different senses in the history of philosophy. (*a*) During the period of Scholasticism (q.v.), realism denotes the doctrine that universals have in some sense an existence which is independent of the particular things that appear to the senses. This theory is derived from Plato's doctrine of ideas, and goes back ultimately to the Socratic view that only through the concept, or universal idea, is it possible to obtain real knowledge. Plato, developing this position, maintained that the universals, as ideas, exist apart from the world of sensible appearances, and form the true and abiding reality, while the latter is merely the world of imperfect copies, the transitory and inadequate representations of this true world of supersensible existence. In spite of the differences in name, then, and the necessary difference of interest in the problem due to the special intellectual outlook of the times, mediæval realism in its earlier and extreme form is identical in standpoint with Platonic Idealism. The later mediæval realists, under the criticism of nominalism (q.v.), modified the extreme view that universals exist apart from things, in the same direction in which Aristotle modified Plato's doctrine of the separate existence of ideas. That is, instead of defending the extreme proposition that universals exist prior to and independent of things (*universalia ante rem*), they maintained with Aristotle that it is the universal, the type or form, that constitutes the particular an individual thing, and that the two are therefore always found together (*universalia in rebus*). The whole problem of the relation of the universal and the particular, as it presented itself to the Scholastic mind, received its most adequate statement and solution at the hands of Thomas Aquinas. He pointed out that there is a sense in which all of the formulas that had been proposed by realists and nominalists alike are true and justifiable. We may say that the universal is prior to the thing and independent of it, inasmuch as we must suppose that the idea as a universal, existed in the mind of God before particular things were created; and in this sense we may therefore accept the statement *universalia ante rem*. But it is the presence of universals that gives to particulars their reality, and it is through their presence in things that they are known to us; therefore the formula *universalia in rebus* is justified. Furthermore, it is the particular, not the universal, that is first known to us. So that from the standpoint of our knowledge, we may admit the nominalistic proposition *universalia post rem*.

(*b*) In modern philosophy, realism has an entirely different meaning, and is directly opposed to idealism (q.v.). Realism in modern systems assumes many forms, just as idealism does, and the two views approximate to each other in so-called doctrines of ideal-realism. But yet the fundamental distinction between these two types of thought remains, and may be definitely stated as follows. Realism maintains that the universe is composed of a larger or smaller number of «reals» that exist in and for themselves, independently of any relation to mind. Its main historical contention has been in opposition to any theory that would reduce the world to a system of ideas. Usually the argument of the realists has been directed against the type of idealism that attempts to interpret reality in terms of the consciousness of finite individuals. But it also maintains that real things possess a being outside and in a real sense independent of the absolute experience of God. We may grant, the realist would argue, that God knows all things, yet these things are not merely his ideas, but possess a reality and independence of their own. These real things are variously conceived in the different systems. In the Scottish Philosophy (founded by Thomas Reid 1710–96), we have the doctrine of «Natural Realism.» That is, things are regarded as real just as they are given through immediate perception. In knowing, the mind deals directly with independent real things. This reality is guaranteed by «Common Sense,» or the fundamental intuitions of mankind. By Kant, on the contrary, the world of perceptive experience is regarded as merely a phenomenon of consciousness. There remains for Kant, however, a world of things-in-themselves beyond experience which can never be known, but which we are necessarily obliged to think as the basis of the phenomenal world. As completely unknown and unknowable, this world of ultimate reality is incapable of any description or theoretical treatment whatever. Herbert Spencer, who speaks of his view as «Transfigured Realism,» occupies fundamentally the same position as Kant. Herbart (1776–1841), while agreeing with Kant that the world of sense experience is phenomenal and exists only for a knowing consciousness, still holds that it is possible to define and determine by means of metaphysical investigation the nature of reality in itself. He therefore postulates the existence of a plurality of absolute «Reals» (*Reale*), each of which is simple and unchangeable, and between which relations obtain which give rise to the phenomenal order of experience. Leibnitz (1646–1715) in his doctrine of Monads, Fechner (1801–87), and Lotze (1817–81), regard the ultimate of nature of reality to be a system of psychical forms of existence or souls.

(2) In the Fine Arts and in Literature, Realism is opposed to Idealism. In general, it may be said that realism insists on correspondence with nature, on representing things as they are actually found in experience, while idealism tends toward an imaginative treatment which does not limit itself to reality as actually known. These two methods of treatment can never be absolutely exclusive of each other. In the work of any given individual one element or the other may be most prominent, but both must be present if the picture or statue or writing is to rank as an artistic production. Both in the choice of subject and in the details of his treatment the realistic artist idealizes: that is, he interprets the actual by isolating it from the context or environment in which it appears, and which serves to some extent to hide its true significance, and secondly, he also idealizes by representing in his treatment what is universal and essential, omitting certain things and selecting others with this end in view. On the other hand, the idealist who

"bodies forth the forms of things unseen," or sings of "a light that never was on sea or land," must nevertheless be "true to nature," in the sense that his imagination must work in accordance with the laws of reality. Otherwise the result is something grotesque and fantastic. We do, however, speak of the work of any particular individual as realistic or idealistic according as the treatment shows more prominently one tendency or the other. There are three ways in which these different tendencies, or attitudes of mind, are shown in the fine arts and literature. In the choice of a subject matter, the realist selects either something actually existing, some familiar scene, or well known event, or at least, if he does not make an exact transcript of a particular object or set of occurrences, it is the concrete individual things of experience with which he deals. Idealism, aiming more directly at the representation of what is universal and typical, constructs for itself its forms and matter, choosing to express itself through a representation it may be, of angels, Graces, or Madonnas, or through a literary portrayal of events and occurrences of some past time that admits of free imaginative treatment. This difference in choice of subject matter also carries with it important variations in manner of portrayal. As realism aims more directly than idealism at correspondence with nature, it is clear that it must emphasize to a greater extent fulness and accuracy of detail. But there is also a difference in the kind of detail that is chosen, and in the emphasis that is given to details of different characters. As it is the object of realism to represent its subject matter in concrete, individual form, the details which are essential to produce this impression are naturally emphasized. An idealistic treatment, on the other hand, seeking to represent more directly the universal and essential, necessarily gives an entirely different value to the various details, omitting, it may be, much that would be regarded as essential in the school of realism, and giving a prominent place to what the latter might keep in the background. It is false art and a false realism, however, that emphasizes what is ugly, unpleasant, and pathological in such a way as to make these the most prominent features of the total work. This *réalisme* has rightly been held to be characteristic of a decadent art, of an art that is inevitably suicidal. For the real, which it is the business of art to reveal and portray, in nature and in human nature alike, is the universal, the abiding, and hence the normal; for what is diseased and monstrous are necessarily particular and transient. Art, like all conscious activity, can only live so long as it assumes that what is rational in the fullest sense must be real.

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Realschulen, rā-äl'shoo-lĕn, a class of institutions in the German system of secondary education characterized by the emphasis laid upon the study of the sciences, mathematics, and modern languages as opposed to the gymnasia in which the classics constitute the principal feature of the curriculum. The Realschule took its rise in Germany in the early part of the 18th century, but did not attain its full development until the second half of the 19th century, when the tremendous progress of science compelled, after a long struggle, the recognition of this type of school as of equal rank with the gymnasia in the national system of education. In the struggle, however, between the classical school and the scientific school a mixed form was developed, approaching more nearly to the Realschule in the importance attached to the non-humanistic branches, but including Latin in its lists of studies. This type of school is known as the Real-gymnasium, and between it and the gymnasium the differences are growing less every year, especially since the study of Greek in the Prussian gymnasia was rendered non-obligatory in 1900. Real-gymnasia are, however, included under the general designation of Realschulen, a term which, in its broadest signification, includes the following classes: (1) *Oberrealschulen* (Upper Real Schools), scientific schools with a nine years' course, giving no instruction in the ancient languages; (2) *Realgymnasien* (Real-gymnasia), scientific schools with a nine years' course, giving instruction in Latin; (3) *Realschulen* (in a stricter sense), the same as the *Oberrealschulen*, without the highest class, giving thus a seven years' course; (4) *Realprogymnasien*, bearing the same relation to the *Realgymnasien* as the *Realschulen* to the *Oberrealschulen;* and (5) *Höhere Bürgerschulen* (higher middle schools), offering a six years' course without Latin. While the Real-gymnasium has been approaching the classical schools in character, the Real-schools proper have been extending their scope so as to include various forms of technical and even industrial education. Graduates of Real-schools are ineligible for admission to various departments and faculties in the universities, the most liberal conditions prevailing in Prussia, where only the faculty of theology is closed to them.

Realty and the terms real property and real estate denote the interest one has in lands; it applies not only to ground but to everything which is attached or a part of it, as trees, stones, houses, or other structures. Timber, grain, and grass rooted to the soil are realty, though when severed they become personalty. Any crop which is an annual product of the soil when ripe is considered as personal property. Permanent buildings erected on one's land without permission become the property of the owner of such land, without regard to the ownership of the materials. Fixtures or things which have been attached to the realty and cannot be removed without injury to it, or which have become so adapted to the building or land as to be necessary to its use, are considered a part of the realty. In addition to the elements of realty which have been above described, are rights which are connected therewith, such for example, as a right of way, a right to the use of water course and easements. An uninterrupted use of any easement or right for 20 years, or any less period fixed by statute raises presumption of title. The various estates which one may possess in realty had their origin in the feudal system of England, the fundamental principle of which is that the king was the original proprietor of all the land in his kingdom, and no one came into any part of it except by gift from him, or in return for feudal services, and thus the land was divided among a graded body of owners beginning with the king's noblemen. In the United States all the instances of feudal tenure have been abolished. In Canada the tenure by which land is held varies in the different provinces, some being largely regulated by a statute enacted during the reign of George III.

Title has been defined as a means whereby the owner of lands has the just possession of his property; title may be acquired by descent, that is, through the death of an ancestor, by purchase, or by operation of law. The legal title of land is usually transferred from one person to another by means of a deed, the many essentials of which are fixed by the statutes in various jurisdictions.

Ream's Station, Battle of. As the extension of Gen. Grant's left to Globe Tavern on the Weldon Railroad (see GLOBE TAVERN, BATTLE OF) did not prevent Gen. Lee's use of the road as a line of supply up to a point within a day's wagoning to Petersburg, Gen. Grant determined to destroy the road as far down as Rowanty Creek, 13 miles beyond Globe Tavern. On 22 Aug. 1864 Gen. Hancock, with Miles' and Gibbon's divisions of the Second Corps and Gen. Gregg's cavalry division, in all about 8,500 men, moved to the left, and by night of the 24th had destroyed the road from Globe Tavern to a point three miles south of Ream's Station, and 12 miles from Petersburg. During the 24th Gregg's cavalry was sharply attacked by Gen. Butler's division of Confederate cavalry, and at night Gen. Meade informed Hancock that Confederate infantry was moving in his direction, but as yet none had been seen by Hancock. At daylight of the 25th a cavalry reconnoissance drove in the Confederate pickets, and Gibbon was ordered to move out from Ream's Station and complete the destruction of the road. Gibbon had hardly gotten well on the road, when the Union cavalry was driven in by cavalry supported by infantry, and he was obliged to deploy a strong skirmish line to check the enemy in pursuit. Prisoners taken from three of Gen. A. P. Hill's divisions showed that the Confederates were in strong force and Gibbon was ordered back to the Ream's Station intrenchments, where he arrived at 10 A.M. and united with Miles' division. The intrenchments were very light and had been hurriedly thrown up by Gen. James H. Wilson in his cavalry fight near that place late in the preceding June. They ran along the railroad about 700 yards and then were drawn back on the right and left about 800 or 900 yards, at nearly right angles. Both flanks were exposed to reverse fire from the front. Miles held the right half of these works, Gibbon the left half. Gregg's cavalry held the approaches in the direction of Petersburg and Dinwiddie Court House. When Hancock's movement became known to the Confederates Gen. A. P. Hill, with the larger part of his corps, together with G. T. Anderson's brigade of Longstreet's corps and Gen. Wade Hampton's two cavalry divisions, marched to prevent the destruction of the railroad, and at 2 P.M. of the 25th Gen. Wilcox's division made two attacks upon Miles, which were repulsed, leaving killed and wounded within a few yards of Miles' front. At 5 P.M. Hill opened a heavy artillery fire and, at the end of 15 minutes, Gens. Heth and Wilcox, with five brigades and three regiments, made another assault upon Miles, and a part of his line, held by raw recruits, gave way, abandoning a battery. At the same time the right of Gibbon's line gave way and two more batteries fell into possession of the Confederates. Gibbon was ordered to retake his lost ground, but his troops, many of whom were new recruits and drafted men, responded feebly and fell back under the first fire. Miles rallied the 61st New York, and by desperate fighting retook a part of his line and his lost battery. Hampton's cavalry now attacked Gibbon and drove him entirely from his works, but was checked by a heavy flank fire from Gregg's dismounted cavalry, upon which Hampton turned on Gregg and forced him back to the left of a line which Gibbon had established a short distance in rear of the intrenchments from which he had been driven. An effort made to retake the intrenchments failed because of the inability of the Union commanders to induce their men to go forward. At dark Hancock withdrew from the field. Gen. Hill made no attempt to follow up his advantage, but returned to the Petersburg intrenchments, leaving Hampton's cavalry at Ream's Station. The Union loss was 669 killed and wounded, and 2,073 captured or missing, together with 12 stands of colors and nine guns. The Confederate loss, as reported by Hill, was 720, chiefly, if not entirely, killed and wounded. Consult: 'Official Records,' Vol. XLII.; Humphreys, 'The Virginia Campaign of 1864-5'; Walker, 'History of the Second Army Corps'; The Century Company's 'Battles and Leaders of the Civil War,' Vol. IV. E. A. CARMAN.

Reapers and **Reaping.** See AMERICAN FARM IMPLEMENTS.

Rear'horse. See MANTIS.

Rearick, Peter Anton, American naval officer: b. Maryland, 12 Nov. 1838; d. Washington, D. C., 9 Feb. 1901. He entered the navy in 1860, was appointed third assistant engineer, and served through the Civil War with promotion, becoming first assistant engineer in 1864. In 1874 he was made chief engineer and served in that capacity until 1900, when he was retired with rank of rear-admiral.

Reasoning, or **Inference,** is a mental process in which we advance from some known facts to the truth of some other fact which is different from the starting-point. The basis for the transition is always found in the knowledge from which we set out: this is taken or assumed to be real, and in it is found the ground and justification for the advance to something else. The differentia of reasoning thus appears to be mediation; when we reason we infer that something is true because something else is true. Knowledge derived from reasoning may therefore be termed mediate, as opposed to the immediate knowledge obtained from sense perception and memory. The question at once arises how any mental content can justify an advance to something different from itself? How are we ever warranted in passing from the known to the unknown? This is not merely the question that Mill raised as to whether all syllogistic reasoning — all advance from premises to conclusion — was not a *petitio principii;* but it concerns all reasoning, inductive and deductive alike. The dilemma is that if the result is not contained in the starting-point the advance does not seem to be justified; if it is already present, the reasoning shows nothing new. The view of Leibnitz was that all reasoning is analysis, a drawing out and fuller explication of the original datum of the mind. Kant pointed out that thinking involves also synthesis, new constructions and additions to the material from which it starts, and he takes as the fundamental problem of his 'Critique of Pure Reason' the question, how such synthetic judgments are possible. His answer is essentially identical with that which Aristotle gave, namely, that the mind or reason (νοῦς) itself enters into the process as a premise — or. in other words, that it is through the creative activity of the mind that the new truth is reached. Whether or not one can connect one fact with another in a logical way depends upon one's intellectual ability to discover points of essential resemblance or identity between facts. The good reasoner is he who can look beneath the surface and detect identities that are not at once obvious, as Newton, for example, did when he reasoned from the fall of the apple to the movements of the heavenly bodies. Reasoning, then, may be defined as the process of discovering essential resemblances or points of identity between things.

It follows from what has been said that reasoning is not a process or function of mind that can go on apart from experience. The thinkers of the modern period down almost to the end of the 18th century, continued to believe that reason was a kind of special organ or faculty that could yield truth of the highest order of certainty quite apart from ordinary experience. It was Kant who first clearly and incontestably showed the impossibility of deriving knowledge from reason taken in abstraction from ordinary sense experience. Kant, however, uses the term Understanding (*Verstand*) for the thinking faculties as employed in interpreting experience, and reserves the name Reason (*Vernunft*) for the vain and illusory attempt of thought to operate in independence of any given material of experience. Apart from this terminology, however, which has not been generally followed, the result of Kant's teaching was to exhibit the close and essential connection that exists between thinking and sense-perception: on the one hand, thought is empty apart from the material of sense-perception, and, on the other, what we call ordinary perceptive experience is constantly interwoven with more or less explicit processes of reasoning. Reasoning does not go on in a vacuum, nor is it a separate and distinct function of mind that in some mysterious way spins truth out of itself. But reason is on one side a universal function of receptivity; it receives its material from every channel of experience, and is itself just the unifying, co-ordinating, and systematizing life of experience. Deduction and induction are often spoken of as if they were distinct species of reasoning. Reasoning, however, is always one and the same process. It consists, as we have seen, in connecting parts of experience by the discovery of some identical element in them. This identity, as present in various particulars, we may speak of as a universal, or general principle, and therefore say that when we reason we unite particulars through a general law or principle. Now, the difference between deduction and induction is a difference in the starting-point and in the direction in which we proceed. If we are already in possession of the general law, and set out to apply it to particular cases, we are using deduction. If, however, our starting-point is the particular instances, then we reason inductively to discover the universal law of connection. In both cases the structure of the completed inference is the same, and consists in the connection of particulars, in virtue of our insight into the universal law or principle expressed in them.

In this reference to a universal principle, we have also that which distinguishes reasoning from the transition from idea to idea of the associative process. In a large part of the conscious life which usually is described as thinking, one idea by its very presence seems to call up another, without the apprehension of any universal or essential law of connection. But this is mere drifting on the part of the mind. In reasoning the mind is fully awake; it sets a definite purpose before it, and proceeds by active attention and analysis to discover essential and necessary points of connection. It thus uses association for its own purposes; so that if we define reasoning as a process of association, we must add that it is association guided and controlled at every step by the purposes of thought itself. How conscious and explicit must this direction be before we can call the process reasoning? Can animals properly be said to reason? These questions do not admit of any off-hand answer. The conscious direction of the mind, the clearness with which it apprehends the universal in the particular, is a matter of degree. We may say that some direction on the part of the mind then must be, as well as some apprehension of the terms as universal, if reasoning is to occur, without attempting to determine just when these conditions are fulfilled in any individual mind or in any species. What we call conscious reasoning, is doubtless continuous with associative and instinctive mental processes that seem entirely mechanical and irrational, and the connection between the two extremes may be mediated by actually observable processes. This continuity, however, gives no justification for refusing to regard the differences as important, or for explaining either extreme of the process in terms of the other. See DEDUCTION; INDUCTION; LOGIC.

Consult: Bosanquet, 'Logic,' Vol. II. (1888); James, 'The Principles of Psychology,' chap. xxii. (1890); Creighton, 'An Introductory Logic,' Part III. (1898); Stout, 'Analytic Psychology' (1896); see also the bibliography under LOGIC.

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Réaumur, rā-ō-mür, **René Antoine Ferchault de**, French physicist: b. La Rochelle 28 Feb. 1683; d. La Bermondiere, Maine, 17 Oct. 1757. He studied under the Jesuits at Poitiers, and afterward at Bourges, and went to Paris in 1703. His relative, the president Hénault, introduced him to the savants of the metropolis, and in 1708 he was chosen a member of the Academy of Sciences, to which he had presented some memoirs on geometry. For nearly 50 years he continued to be one of its most active members, his labors embracing the arts, natural philosophy, and natural history. He was appointed to assist in the 'Description des Divers Arts et Métiers,' published by the Academy, and in executing his part of the undertaking pointed out the way to various improvements by the application of the principles of physics and natural history. He made important observations on the formation of pearls, and discovered that the «turquoises» of Languedoc consisted of the fossil teeth of extinct animals; but among his most useful researches must be reckoned those of which he gave an account in his 'Traité sur l'Art de Convertir le Fer en Acier, et d'Adoucir le Fer Fondu' (1722), in which he first made known in France the process of manufacturing steel. He received therefor a pension of 12,000 livres (about $2,400). As a natural philosopher he is principally celebrated for the invention of an improved thermometer, which he made known in 1731. (See THERMOMETER.) The fabrication of porcelain also occupied much of his attention, and led him to the discovery of a kind of enamel, called the porcelain of Réaumur, in 1739. His 'Mémoires pour Servir à l'Histoire des Insectes' (1734–49) places him in the first rank of modern naturalists. In it he demonstrated, among various things, the correctness of Peysonnel's assumption that corals are not plants, but animals.

Reavis, James Bradly, American lawyer and jurist: b. Boone County, Mo., 1848. He entered Kentucky University, but did not complete the course, was admitted to the bar in Hannibal, Mo., in 1872, and for two years was editor of the Monroe City *Appeal*. In 1874 he removed to the West, finally settling in Washington Territory, where he established a law practice. He was a member of the upper house of the territorial council in 1888, and a regent of the territorial university, until Washington became a State. In 1889 he was an unsuccessful candidate for supreme judge, and from 1896 to 1902 was chief justice of the Washington supreme court.

Rebapti'zers, those who taught that the repetition of baptism was under certain circumstances imperative. The term is specifically used of the Baptists who enforce rebaptism in the case of all who have not been baptized by immersion. Views with regard to rebaptism have been varied. Many early Christians declared it unnecessary even for one who had been baptized by an unbeliever, or by a child in play. In doubtful cases the hypothetical or conditional form was enjoined, as in the Book of Common Prayer, and in accordance with the decretal of Alexander III. (1159–81).

Re'bec, or **Rebeck**, a stringed musical instrument of the violin kind, said to have been introduced by the Moors into Spain. It soon became popular all over the Continent, being the favorite instrument of minstrels, and of village musicians, and up till the end of the 17th century, playing the same important part at fairs, rustic games, and weddings as does the violin at the present day. It was somewhat larger than the latter instrument, but had only three strings, which were tuned in fifths, and rubbed with a bow. The neck of the rebec terminated in a more or less grotesque representation of a human head.

Rebecca, a character in Scott's 'Ivanhoe', daughter of the Jew, Isaac of York. She falls in love with Ivanhoe and nurses him after the tournament of Ashby, and he in turn saves her life by appearing as her champion in the lists after she has been convicted of sorcery and condemned to be burnt at the stake. She departs from England with her father to live in Spain.

Rebec'caites, or **Rebekah's Daughters**, a singular association formed in South Wales, in 1839, for the destruction of turnpike-gates and toll-houses. The rioters were generally dressed in women's clothes, under a leader in the same guise, and made their attacks by night on horseback. The curious appellation by which they designated themselves was derived from the scriptural passage regarding Rebekah — «Let thy seed possess the gate of those who hate them.» Successful for a time they were emboldened to greater lawlessness, and were attacked and dispersed by the military.

Rebekah Lodges. See ODD FELLOW.

Rebel Yell, the cry of the Confederate troops as they rushed to battle in the Civil War, although as a matter of fact, they frequently shouted the names of their States, as «On Virginia!» «On North Carolina!» — and so forth. It is difficult to interpret the rebel yell in written language. It was very different from the full-toned hurrah of the North, being more like a shriek. Near the crisis of a charge, the men would change from a double-quick to a mad rush, wildly yelling, «Y-Yo Yo — Wo-Wo,» for the triple purpose of encouraging each other and confusing and terrorizing the enemy.

Rebellion, an uprising with force and arms against established authority. A rebellion may be an armed outbreak for the purpose of obtaining the redress of a grievance, or preventing the enforcement of an obnoxious law, Shays' Rebellion in Massachusetts having been an example of the former, and the Pennsylvania Whiskey Insurrection of the latter. Rebellion of a more formidable character is that which attempts to establish a new and independent organization in place of the existing government. Such was the American Revolution, and such also was the unsuccessful attempt to perpetuate the Southern Confederacy. Old World rebellions have been chiefly dynastic at least up to the 19th century — that is, wars between reigning families, and others, usually akin to them, which claimed the right to rule. The rebellion against Charles I. of England was of a different character, being prompted by aspirations for civil liberty and religious reform. The expulsion of James II.

was of a similar motive, and the American Revolution was a struggle for the inalienable rights of man.

In former ages, and up to a very recent period, conquered rebels were treated with great severity, being put to death, maimed, or enslaved. In partly civilized countries such as China rebels are treated even now with the greatest cruelty. The more advanced nations, however, while retaining on their statute books the Draconic code of times gone by, treat beaten insurgents with leniency. After the downfall of the Southern Confederacy the only penalty inflicted was the disfranchisement for a time of the leaders of the rebellion, all being eventually admitted to the full rights of citizenship. British subjects who took sides with the Boers in the late South African war were, when convicted, imprisoned for short terms and disfranchised, although most of them probably escaped all punishment.

With the extension of suffrage came a consequent ability of the people to secure redress of wrongs without resort to violence. The causes which provoked rebellion in olden times are disappearing, while, apart from Carlist insurrections in Spain, there have been no dynastic rebellions in Europe for many years past.

Rebellion, War of. See CIVIL WAR IN AMERICA.

Reber, rā'bĕr, **Franz von,** German art-historian: b. Cham, Bavaria, 10 Nov. 1834. He studied in Munich, Berlin, and Rome, became a lecturer at the University of Munich in 1858, was appointed professor at the Polytechnicum there in 1863, and in 1869 occupied the chair of history of art in that institution. In 1873 he became director of the Royal Gallery. He has translated Vitruvius' 'Architecture' (1865) and Rooses' 'History of the Antwerp School of Painting' (1880), and has written: 'Geschichte der Baukunst im Altertum' (1864-7); Kunstgeschichte des Mittelalters' (1886); 'Geschichte der Malerei vom Anfang des 14. bis zum Ende des 18. Jahrhunderts' (1894); 'Die phrygischen Felsendenkmäler' (1897); etc.

Reber, rā-băr, **Napoleon Henry,** French composer: b. Muhlhausen, Alsace, 1807; d. Paris 1880. After studying with Reicha and Le Sueur, he wrote chamber music of remarkable merit, and in 1851 was appointed professor in the Conservatory, and succeeded Halévy in the chair of composition 1862. Among his works are: 'Le Diable Amoureux' (1840), a ballet; 'Le Nuit de Noël' (1848); 'Le Père Gaillard' (1852); 'Les Papillotes de M. Benoist' (1853); and 'Les Dames Capitaines' (1857), all four comic operas. He has also produced some instrumental work of a high order — four symphonies, one overture, one series for the orchestra, three stringed quartets, one stringed quintet, one pianoforte quartet, seven pianoforte trios, and miscellaneous pieces. His 'Traité d'Harmonie' (1862) is a standard work.

Rebis'so, Louis T., American sculptor: b. Italy 1837; d. Norwood, near Cincinnati, Ohio, 3 May 1899. At 20 he joined in Mazzini's attempt to establish an Italian republic (see MAZZINI, G.), and was obliged to leave Italy. Taking refuge in the United States, he settled in Boston, Mass. Subsequently he went to Cincinnati, Ohio, where his fame as an artist developed. His leading works are the equestrian statues of Gen. McPherson in Washington, D. C.; of Gen. Grant in Lincoln Park, Chicago, and of Gen. W. H. Harrison in Cincinnati.

Re'bus, a mode of expressing words or phrases by pictures of objects whose names bear a resemblance to those words, or to the syllables of which they are composed. Many of the ancient coats of arms were rebuses on the names of those who bore them; thus a lock and a heart for the name of Lockhart, an eye and a ton (a barrel) for that of Eyton, etc. In heraldry, a rebus is a device intended to represent a proper name by a picture; a bearing or bearings on a coat of arms, containing an allusion to the name of the owner; as in the coat of the family of Arches, which consists of three arches, two simple and one double, borne on a shield; and that of the Dobell family, who bore on a sable shield a doe passant, between three bells argent.

Recall. See REFERENDUM.

Récamier, rā-kä-mē-ā, **Jeanne Françoise Julie Adelaide Bernard,** French social leader: b. Lyons 4 Dec. 1777; d. Paris 11 May 1849. She was educated at the convent of La Deserte. At 16 she went to Paris, whither her father, a wealthy banker, had transferred his business. Her extraordinary beauty and talents brought round her shoals of suitors belonging to the world of letters, finance, and politics, and in 1793 she was married to Jacques Récamier, a rich banker, more than double her own age. The Récamier salon was long filled with many of the celebrities of the day. Though she wrote nothing, she, by her confidential intercourse with Chateaubriand and others, exercised no slight influence on French literature. Under the Empire she was opposed to Napoleon, as he had placed her father under surveillance for his royalist tendencies, and Napoleon took his revenge by refusing to support the bank of her husband during a crisis. It accordingly failed, and Madame Récamier was obliged to quit Paris. She took up her residence with her friend Madame de Staël at Coppet, and afterward traveled, like her, till the downfall of Napoleon, when she again opened her salon in the Abbaye-aux-Bois at Paris. Her 'Recollections and Correspondence' appeared in 1859.

Recapit'ulation, or **Biogenetic Law,** in zoology, terms applied to the parallel which exists between the embryonic development of an individual animal (ontogeny) and the historical evolution of its race (phylogeny). This parallel is explained by the theory of evolution (q.v.), according to which, in the words of Sidgwick, «the developmental history of the individual appears to be a short and simplified repetition, or in a certain sense a recapitulation, of the course of development of the species.» This class of facts was recognized more or less completely by the earliest naturalists, and were extensively studied and formulated by Von Baer and Agassiz previous to the explanation of them by means of the doctrine of descent; but it should be added that obscurities still exist, concerning the explanation of which embryologists are in doubt or at variance. Examples may be found in the embryological development of all vertebrates. Thus the frog develops through stages in which the embryo just before hatching is very fish-like, after hatching becomes a tadpole which exhibits many newt-like characters; and finally reaches the permanent frog stage. This accords with the comparative rank of the fish, newt and frog groups in classification; and also with the succession appearance of these groups. Man, as the highest animal, exhibits most completely these phenomena. In the earliest stages the human embryo is indistinguishable from that of any other creature. A little later the cephalic region shows gill-slits, like those which in a shark are a permanent feature, and the heart is two-chambered or fish-like. Further development closes the gill-slits, and the heart changes to the reptilian type. Here the reptiles stop, while birds and mammals advance further; but the human embryo in its progress to the higher type recapitulates and leaves features characteristic of lower mammalian forms — for instance, a distinct and comparatively long tail exists. Most of these changes are completed before the embryo is six weeks old, but some traces of primitive and obsolete structures persist throughout life as «vestiges» or «rudimentary organs,» and others appear after birth in infancy, as the well-known tendency of babies to turn their feet sideways and inward, and to use their toes and feet as grasping organs, after the manner of monkeys. This recapitulation of ancestral characters in ontogeny is not complete, however, for not all the stages are reproduced in every case, so far as can be perceived; and it is irregular and complicated in various ways, among others by the inheritance of acquired characters. The most special students of it, as Haeckel, Fritz Müller, Hyatt, Balfour, etc., distinguish two sorts of recapitulation «palingenesis» and «cœnogenesis,» the last manifested most completely in the metamorphoses of insects. See Embryology, and consult authorities mentioned thereunder.

Receipt, in law, a written document, declaring that certain goods or a sum of money have been received. When made out in full, a receipt should contain (1) the date when the merchandise or money was received, (2) the name of the person or firm from whom received, (3) the name of the person who received it, and (4) for what the money is paid or deposited. A receipt may be in full or in part payment of an account, and operates accordingly. A receipt, though evidence of payment, is not absolute proof, and this evidence may be rebutted by proving that it was given under misapprehension.

Receiver, in law, is an officer of the court through whom the court, on account of its jurisdiction, takes possession of property which is the subject of a suit, for the purpose of preserving it from injury or loss, secures the proceeds and finally disposes of them according to the rights of all parties interested. Receivership is a remedial agency for the purpose of preserving the property in question from waste, destruction or deterioration pending litigation; it is auxiliary to the main action. It is a remedy which originated in the English Court of Chancery and is purely equitable. Under the existing English law, and also that in Canada, a receiver may be appointed when the court deems it just or convenient. In the United States, courts of equity have general authority to appoint receivers, and in most States by statutory provision. The courts are generally disinclined to appoint a receiver, except that from all the circumstances it appears essential for the purpose of the preservation of the property in controversy. Technical injuries and circumstances which are doubtful are insufficient. A receiver will be appointed to prevent a fraudulent transfer, or possession of property, or for the protection of estates, or of property of a partnership where dissolution is desired and the partners cannot agree; of mortgaged property, foreclosure proceedings, corporations which are insolvent, or which are fraudulently managed. The appointment of a receiver rests entirely within the discretion of the court to which the application is made, and the court also has discretion as to its choice of receiver. One will not be appointed a receiver who is not qualified to perform his duties, and he must be impartial, independent and disinterested. A corporation may be appointed a receiver if authorized by its charter. In order to obtain a receiver one must show the right to the property, or a lien upon it, or that the property in question was obtained by fraud, or is in danger of loss from waste, or the misconduct or insolvency of the party in possession, and the circumstances must show extreme necessity. A receiver is created by the court whose officer he is and is under its control, supervision, and protection. His duty is purely ministerial and the utmost good faith is required of him; his acts should be with the general or special authority of the court and must be without discrimination for the interests involved. A receiver may employ counsel, agents and assistants, make necessary repairs, pay taxes and bring suits: he must keep the property insured and is required to give a bond for faithful performance of his duty. He takes complete possession of the property at the time when appointed; his liability is generally official, and he is responsible to any person who sustains loss through his negligence or misconduct in relation to his trust; he is entitled to a compensation for his services, which is in some jurisdictions fixed by statute, in others by the discretion of the court.

Recent Period, that division of the geological time-scale including the most recent portion of geological history. It is usually thought of as beginning with the appearance of man on the globe and running down to the present, and is therefore sometimes called the Human Epoch. It follows immediately upon the Pleistocene Period (q.v.) and is treated as a subdivision of this by some geologists, while others group Pleistocene and Recent under the Quaternary Period (q.v.). See Geology.

Rechabites, rĕk'a-bīts, members of a kind of religious order in ancient Israel whose rule was in some respects like that of the Nazir or Nazarites: like them they were bound by vow to abstain from the use of wine. In their contempt for luxuries and the ways of settled life, they chose to live in tents rather than houses, and refused to sow grain or plant vineyards; their ideal was the nomad patriarchal life amid their flocks. The order had its origin in the northern kingdom of Israel, and was founded by Jonadab or Jehonadab, son of Rechab (whence the name Rechabites), in the reign of Jehu, king of Israel (2 Kings x.). After the fall of the kingdom of the North a body of the Rechabites entered the kingdom of Judah and continued to live apart from cities and towns till at the approach of Nebuchadnezzar they took refuge in Jerusalem. Independent Order of Rechabites is the style of a total-abstinence beneficial society founded in England 1835 and of which a branch was instituted in the United States 1842. In 1902 the order had 270,000 members and the disbursements of the previous fiscal years were $793,682; in the United States the Rechabites had three «tents,» 35 «sub-tents.»

Recife, Brazil. See PERNAMBUCO.

Recip'rocal, in grammar, reflexive. Applied to verbs which have as an object a pronoun standing for the subject; as, «Bethink yourself.» It is also applied to pronouns of this class. As a noun, that which is reciprocal to another thing. Specifically, in mathematics, the quotient resulting from the division of unity by the quantity. The reciprocal of a vulgar fraction is the denominator divided by the numerator.

Reciprocity. See UNITED STATES, RECIPROCITY.

Recitative, rĕs''ĭ-tạ-tēv' (Italian, *recitativo*), a species of musical recitation, forming the medium between song and rhetorical declamation, and in which the composer and performer, rejecting the rigorous rules of time, endeavor to imitate the inflections, accents, and emphasis of natural speech. Although the rules of time and rhythm are not strictly observed, recitative is written generally in common time, in order to facilitate the reading. In its approach to speech, therefore, recitative is mostly syllabic song, that is, each syllable has generally but one tone, and the tones themselves are less prolonged than in *song* strictly so called. Hence recitative has not a distinct, developed melody, and a regular modulation; it may, according to the meaning of the words, pass with comparative freedom through the various tones. On the other hand, the tones of recitative are generally musical tones, of distinct height or depth generally, because in *recitativo parlante*, in the *opera buffa*, the tones become closely allied to those of speech. When recitative approaches still more to strict song, in respect to time and melody, the *arioso* originates. In short recitative may be called *declamation in musical tones.* Recitative includes the simple (by some also called the *parlante*) and the accompanied, or more properly, the *obbligato*. In simple recitative accompaniment also takes place, but it consists only in simple chords, which are given continuously, or interruptedly. In the *obbligato* recitative the instrumental accompaniment is of more importance, and consists of either sustained chords by the greater portion of the orchestral instruments, or even of florid passages. In the recitative much is left to the singer in respect to time, rhythm, and melody, which require much musical judgment and knowledge of harmony, in order to agree with the *obbligato* accompaniment. Peri Caccini and Monteverde are celebrated as having introduced the modern recitative. See OPERA.

Recke, rĕk'ĕ, **Ernst von der**, Danish poet: b. Copenhagen 14 Aug. 1848. His first work was a lyrical drama, 'Bertram of Born' (1873), performed with great success at the Theatre Royal at Copenhagen. Following this came 'King Liuvigild and his Sons' (1878), a tragedy; a dramatic poem 'Archilochus' (1878); 'Knud and Magnus' (1881), a tragedy; 'Fru Jeanna' (1891), a tragic opera; and the 'Duchess of Burgundy' (1891). Between 1876 and 1890 he published several collections of lyrics and in 1881 a great work representing six years of labor in a field in which he is a recognized master, 'Principles of Danish Versification as Manifested in his Historic and Systematic Development.' Besides writing books for children he has published translations of Bornier's 'La Fille de Roland' (1876) and Rostand's 'Les Romanesques' (1896).

Recklinghausen, rĕk'lĭng-how-zĕn, **Prussia**, in the province of Westphalia, 15 miles northwest of Dortmund. It has good Catholic and Protestant schools. Its manufactures include damask, wicks, tobacco, and bricks. There are coal mines in the vicinity.

Réclus, Jacques Elisée, zhăk ā-lē-zā rā-klü, French geographer: b. Sainte-Foy-la-Grande, in the Gironde, 15 March 1830; d. Brussels, Holland, 4 July 1905. After being educated in the college of his native town and at the University of Berlin, he traveled in Germany, England, Ireland, and America. In 1859 he began to contribute to the 'Revue des Deux Mondes' articles on geography, geology, literature, politics, social economy, and other subjects, and also became associated with several geographical journals. During the siege of Paris and the Commune he was a member of the National Guard. Captured early in 1871 he was condemned to deportation, but his sentence was commuted to exile, and he spent some years in Italy and Switzerland. In 1883 the Tribunal at Lyons passed sentence upon him and Prince Kropotkin as being anarchistic leaders associated with the International Workingmen's Association, but Reclus escaped punishment by his absence from the country. In 1892 he was appointed professor of comparative geography in the free university of Brussels. His greatest work is his 'Nouvelle Geographie Universelle: La Terre et les Hommes' (1875–94), a splendid monument of the best geographical learning of our time. There is an English translation by Ravenstein and Keane (1887 onward). His other works include: 'La Terre: Description des Phénomènes de la Vie du Globe' (1867–8), translated into English as 'The Earth' (1871); 'Histoire d'un Ruisseau' (1869); 'Nice, Cannes, Antibes, Monaco, Menton, San Remo' (1870); 'Les Phénomènes Terrestres: Les Mers et les Météores' (1873): 'Histoire d'une Montagne' (1880), translated as 'The History of a Mountain' (1881); and 'L'Evolution, la Révolution et l'Idéal Anarchique' (1898), treating of his social philosophy.

Recognition Marks. See COLORATION, PROTECTIVE.

Recog'nizance, or **Recognisance, in law**, an obligation of record, which a man enters into before some court of record or magistrate duly authorized, with condition to do some particular act; as, to keep the peace, to pay a debt, or the like.

Recollet, rĕk'ŏ-lĕt, or **Recollect, the name** given to certain reformed bodies of the Franciscan and other orders in the Roman Catholic Church. The reformed society was founded in Spain by Juan de la Puebla y Sotomayor, conde de Belalcazar, in 1484, was admitted into Italy in 1525, and into France in 1595. Thence they spread rapidly into Belgium and Germany. In France, before the Revolution, they had 168 houses, forming seven provinces, under the direction of the general of the Cordeliers. The order still exists at Medina, Sidonia, Leon, and Pamplona. It is also known as the Friars Minor of the Strict Observance of St. Francis. See also ORDERS, RELIGIOUS.

Reconcentrado, rē-kŏn-sĕn-trä'dō, a Spanish term applied to the inhabitants of the rural districts of Cuba, whose sufferings, caused by their treatment at the hands of the Spanish authorities, had much to do with provoking war between the United States and Spain. Governor-General Weyler issued a decree that all of the peasant class not actively engaged in the insurrection but at their homes or ranches, should be «reconcentrated» in or near certain towns, disobedience to this degree incurring the penalty of death. Accordingly, these people, noncombatants and mostly old men beyond the ability of army service, feeble old women, children, and babies, were forced to leave their homes and to gather in herds in and near these towns, where they were without food and shelter, «reconcentrated,» to starve and to suffer from exposure to the weather and lack of all comfort. These helpless victims were called «reconcentrados.» General Weyler's purpose was to desolate the island in certain parts so that the insurgents could not get aid and food. With this end in view, the abandoned homes were destroyed and whatever remained of value to the Spaniards was confiscated. Whole districts in the most productive part of the island were thus laid waste. Sugar mills were burned and other industrial property was destroyed. Nearly 400,000 «reconcentrados» were forced to go within the Spanish lines, where no means of subsistence were provided for them. More than 200,000 died of starvation and disease, an appalling record in modern civilization. When the decree, under General Blanco, was issued to permit the reconcentrados to return to their homes, there was but desolation where their homes had been. It was at this time that the American relief work, Red Cross ministration, and other help availed this helpless class, but not to the full extent of their capacities till the American army and navy had driven Spanish rule from Cuba. The British followed a similar course in the Boer war, but with much less inhumanity.

Reconnaissance, rē-kŏn'ā-sans, usually the examination of a territory, district, etc., or of an enemy's position, for the purpose of directing military operations. Also the preliminary examination of a county or district in reference to its general natural character, preparatory to a more particular survey for the purposes of triangulation or the construction of public works, as of a road, canal, railway, etc.

Reconstruction. See UNITED STATES, RECONSTRUCTION.

Record includes anything which is set down in writing for the purpose of preserving memory, and may be of a public or private nature. A record in a law suit is a complete written history of it from its beginning to its determination made by an officer duly authorized. All books and memorials kept by public officers in accordance with the law, or which are connected with the proper discharge of their duty, are regarded as public records, as are also copies of papers which statutes require to be filed in public places. Generally anyone has a right to inspect public records, and in many jurisdictions the removal of public records is regulated by statute, some of which hold that to destroy, or remove, or injure the records is a criminal offense.

Recorde, rĕk'ŏrd, **Robert,** English mathematician b. Tenby, Pembroke, about 1510; d. London 1558. He studied at Oxford, was elected to a fellowship of All Souls' in 1531, studied, and probably taught, mathematics and medicine at Cambridge, and later was instructor in a variety of subjects at Oxford. Having gone to London, he became, it is said, physician to Edward VI. and Queen Mary. In 1551 he was made general surveyor of the mines and money; but despite this post seems to have been imprisoned for debt in King's bench prison, where he certainly died. Among his works were: ‹The Grounde of Artes› (1540–1699); ‹The Urmal of Physick› (1547), a comprehensive treatise on medicine; ‹The Pathway to Knowledge, or First Principles of Geometry› (1551–1602); ‹The Whetstone of Witte, or the Second Part of Arithmetike› (1557), the former a treatise on geometry, the latter on algebra; ‹The Castle of Knowledge, a Treatise on Astronomy and the Sphere› (1551). For over a century his mathematical works were used as text-books in the schools of England. He was the first to use the sign = for equality, and to discover the method of extracting the root of multinomial algebraic expression.

Recor'der, in New York, the title of one of the criminal judges. The title is of ancient English derivation, the recorder in England being a person associated with the mayor and other magistrates of any city or borough, having jurisdiction in a court of record, for their better direction in matters of justice and proceedings according to law. The title of recorder is also given in some American States to an official having charge of real estate and other records.

Recorder, an obsolete musical instrument, formerly popular, resembling a flageolet in shape, with a mouth-piece like a bird's beak. The instrument was wider in the lower half than in the upper; its tones were soft and pleasing and an octave higher than the flute. Milton speaks in his ‹Paradise Lost› of

> The Dorian mood
> Of flutes and soft recorders;

and it is also mentioned by Shakespeare in ‹Hamlet.›

Recreation Piers, piers on the river-front in several of the large American cities maintained as places of recreation for the people, and usually crowded on warm nights in the summer months by those who cannot afford to go out of the city to summer resorts. Music is furnished at the public expense, and order is maintained by the police. Standing forth preeminent and as the leader among the cities providing such breathing-places for the poor is New York City which in 1903 had seven, three located on the East River and three on the North River, Manhattan, and one in Brooklyn, two of which are also open in winter.

Rec'reative Religionists, the name of an association formed in London 1866 for the purpose of providing on Sunday evenings popular lectures on scientific subjects with sacred music at intervals. An effort was made to suppress the work of the association under the provisions of the «Sunday Act,» 21 Geo. III. ch. 49, but it failed, and the Recreative Religionists or Sunday Lecture Society now figures in the registrar-general's report among «sects having registered places of worship.»

Recruiting. See Regular Army.

Rec'tangle, in geometry, a parallelogram or quadrilateral figure whose angles are all right angles. An equilateral rectangle is a square. A rectangle is said to be contained by any two of the sides about one of its angles; thus, if A B and B C represent two adjacent sides, the rectangle is said to be contained by A B and B C, or, as it is sometimes expressed, it is the rectangle under A B and B C. The area of a rectangle is equal to the product of its base and altitude. Rectangles having equal bases are to each other as their altitudes: rectangles having equal altitudes, are to each other as their bases.

Rectify, to refine common alcohol or spirit by distillation. The process of rectifying begins after the spirit itself has been distilled, and consists in removing the impurities from the spirit by fractional or repeated distillation, so far as possible, for it is impossible in this way to get rid of fusel oil. Whiskey, brandy, and rum, if genuine, are made from rectified spirit. See Distilled Liquors.

Rector, in the Protestant Episcopal and Roman Catholic churches, is the clergyman who has the complete charge and care of a parish church. The term rector is also applied in some monastic orders to the chief officer of a convent; and again to designate the heads of universities, colleges, academies, schools, and other educational corporate establishments.

Rectum, the lower portion of the large intestine or colon. The term, however, is a misnomer so far as the human anatomy is concerned, for the bowel adapts itself to the curves of the sacrum, and at one point doubles upon itself. The rectum is from six to eight inches long, extending from the sigmoid flexure to the anus, and is narrowest at its two extremities. The largest and most dilatable portion (ampulla) just above the levator-ani muscle, forms a sort of pocket in which fæces, etc., lodge. The rectum has a mucous coat (membrane), gathered into transverse folds (Houston's valves), forming compartment-like spaces; a submucous and a muscular coat; and at the upper portion, where there is little motion, a peritoneal coat (mesentery).

The tendency of specialists is to consider the rectum as only that part of the bowel below the third sacral vertebra, and devoid of mesentery, and to divide it into two portions, the fixed rectum and movable rectum. The rectum is in close opposition with large pelvic vessels and nerves and a portion of the small intestine; also, in the male, with the bladder, urethra, and prostate gland; and in the female, with the uterus, vagina, and Douglas' cul-de-sac. Its lower portion is surrounded by the hæmorrhoidal plexus of veins. The vessels forming this plexus, as also those of the vaginal and vesicoprostatic plexuses, are very large, frequently communicate, and have many valves. It is in the lower portion of the rectum that hæmorrhoids or piles and many other painful affections occur, as blood-vessels and nerves are numerous, and the muscles powerful.

Diseases of the Rectum.— These include congenital imperfections. The rectum may even be absent, or partially developed, terminating in a blind pouch; or it may abnormally open into the bladder, vagina, uterus, or urethra. These imperfections can be usually remedied by the surgeon.

Threadworms or pinworms frequently inhabit the rectum and cause itching about the anus (pruritus ani). They may be destroyed by injections of lime-water or a solution of oxgall. Abscesses (caused by blows, perforation, sitting upon cold, damp seats, etc.) may form in the loose areolar tissue about the lower part of the rectum and open externally or into the rectum, leaving a fistulous tract (fistula in ano). Benign tumors, fibroma, papilloma, and adenoma, and also carcinomatous and sarcomatous tumors may form in the rectum. Hæmorrhoids, due to disease or a weakened condition of the hæmorrhoidal veins, are common, especially in persons who are on their feet a large part of the time and who are engaged in sedentary occupation. Hæmorrhoidal affections may be relieved by astringents or by operation. Polypus of the rectum (soft and hard), comparatively frequent in childhood, is a tumor resembling in shape a berry or a pear, and having a peduncle. It sometimes bleeds and protrudes at the anus after stool. It is composed of elongated follicles and a network of small blood-vessels. It may be removed by a ligature or by an appropriate instrument. Prolapsus of the rectum, due to a relaxed state of the sphincter-muscles and the coats of the rectum, may be either incomplete or complete, with protrusion from the anus (prolapsus ani). It is observed generally in young children and women, and is brought on by bearing-down strains. Treatment requires the replacing of the bowel and keeping of it in place; and astringents, caustics, and operation are employed as may seem advisable. Stricture of the rectum, or narrowing of its calibre, may be very limited in extent, or may include a considerable portion of it, and is due usually to malignant or syphilitic ulceration. The symptoms include difficult defecation, more or less purulent and bloody discharges, and pain. If not relieved, it affects the general health. Treatment consists of dilatation with rectal bougies, or division of the cicatricial tissue by instruments (colotomy). Ulceration of the rectum may be due to simple inflammation or to dysentery, tuberculous disease, syphilis, or malignant disease. Symptoms vary with the character of the sores and their location. There are usually discharges of pus, blood, and mucus, and some pain and tenesmus. Treatment depends on the nature and extent of the disease and the constitutional condition of the patient. It includes the keeping of the bowel as quiet and free from fæcal matter as possible, the use of simple food, saline aperients, and vegetable astringents, or nitrate of silver. Fissure of the anus, or a tear of its mucous membrane, may extend into the rectum, or a fissure of the rectum may exist by itself. In either case the fissure is usually produced by the passage of hardened fæces and the attendant straining. It is sometimes obstinate. Treatment calls for regulation of the bowels, dilatation, and the application of nitrate of silver or other astringent. Neuralgia of the rectum is sometimes mistaken (before an examination of the rectum is made) for fissure. Treatment as in other neuralgias, except when it is caused by pressure of a displaced coccyx upon sacral nerves. This bone must then be replaced or removed.

Intestinal calculi (enteroliths), gallstones, and fæcal concretions containing, it may be, fruit-stones or berry-seeds, are occasionally found in the rectum. They give rise to more or less tenderness and abdominal pain, severe and intractable constipation, cold perspiration, vomiting, thready and rapid pulse, etc.; and they must be removed. Invagination or intussusception of the rectum, of the upper portion into the lower, as the result of strain and weakened rectal walls, requires surgical aid.

Regular and free movements of the bowels, unattended by straining, are of the greatest importance in the treatment of most rectal ailments, and preventive of many. The fact that the lower portion of the rectum is capable of holding a large amount of hardened fæcal material, while the more liquid matter readily flows by it and out of the body, is not generally understood.

Recusants, rĕk'ū-zants or rē-kū'zants, a term in use under the penal laws of England, when it was sought to force the consciences of the people by legal punishments. Recusants were those persons who refused or neglected to attend divine service on Sundays or holidays in the Established Church, or to worship according to its forms. The word is first met with in temporal courts in the first year of Queen Elizabeth, when it was enacted that all persons who, without reasonable excuse, failed to attend some usual place of prayer, should be censured and fined for every offense 12 pence. In 23 Elizabeth the fine was made for every month £20; and later in the same reign it was enacted that if recusants did not submit within three months after conviction they might, upon the requisition of four justices of the peace, be compelled to abjure and renounce the realm; and if they did not depart, or if they returned without due license, they were to be treated as felons, and suffer death without benefit of clergy. In the case of Roman Catholic recusants the laws were more severe. They were liable to a forfeit of 100 marks (£66, 13*s.* 4*d.*) for hearing mass; for saying it the fine was doubled, and in both cases they had to undergo a year's imprisonment. They were disabled from taking lands either by descent or purchase after the age of 18, unless they renounced their errors, and could not keep or teach schools under pain of perpetual imprisonment. After a first conviction, they could not keep arms in their houses, could not appear within 10 miles of London, could not travel five miles from home without license, could not hold any public office, would not have marriage, baptism, or burial performed, except by a minister of the Established Church; could not bring any action at law or equity, all under penalties of fine and imprisonment. By the Toleration Act (1 Wm. and Mary, ch. 18) all persons dissenting from the English Church, except Roman Catholics and anti-Trinitarians, were allowed to meet for purposes of worship according to their own forms on taking the oaths of allegiance and supremacy. The act was extended to include Unitarians in 1813, and in 1829 the Catholic Emancipation Act granted toleration to Roman Catholics.

Red, one of the three primary colors. Mixed in equal strength and proportion with the other primaries, it yields secondaries, for example, with yellow it forms orange; with blue, violet, etc. Also a pigment. The most useful red pigments are carmine, vermilion (sulphuret of mercury), chrome-red, scarlet-lake (biniodide of mercury), madder-lake, light red, burnt sienna; these are yellow reds. Venetian red, Indian red (carbonate of oxide of iron), and crimson-lake are blue reds.

Red Admiral, a butterfly of the genus *Vanessa*, especially *V. Atalanta*, so called by British collectors. See ADMIRAL.

Red-backed Mouse, a small, chestnut-backed wood-mouse (*Evotomys gapperi*) closely related to the meadow-mouse, which is common throughout the eastern half of the United States and in the Saint Lawrence Valley, and has the general habits of a meadow-mouse.

Red-backed Sandpiper, the dunlin (q.v.).

Red Bank, N. J., town, in Monmouth County; on the Shrewsbury River, at the head of navigation, and on the Central of New Jersey, the New Jersey Southern, and the Pennsylvania R.R.'s; about 25 miles south of New York. It has regular steamer connection with New York, Atlantic Highlands, and other ports. Settlements were made in the vicinity in 1650, by English and Dutch colonists. It was incorporated as a town in 1872. It is an attractive residential town, and a favorite summer resort. It has a number of industrial establishments, chief of which are a large canning factory, carriage shops, clothing factory, boiler works, gold-beating works, and brush factory. About 500 persons are employed in the manufactories. The trade is chiefly in manufactures, farm products, and fruit. It has nine churches. The educational institutions are the Shrewsbury Academy, several private schools, a high school which cost $60,000, public and parish schools, and a public school library. The government is vested in a board of commissioners of five members, elected annually. Pop. (1890) 4,145; (1900) 5,428; (1910) 7,398.

JOHN H. COOK,
Editor 'Red Bank Register.'

Red Bat, a small reddish bat (*Lasiurus boreales*) common in the Eastern United States. See BAT.

Red-bellied Hawk. See RED-SHOULDERED HAWK.

Red-bellied Snake, a harmless snake (*Storeria occipitomaculata*) of the Eastern United States, whose belly is salmon red. It is dull brown above, with a paler stripe along the spine, bordered by one or more rows of blackish dots; a constant feature is three pale reddish blotches on the occiput. Its size and habits are similar to those of the garter-snakes. Two or three other species in the West have red bellies, and are sometimes locally known by the same name.

Red Book, an English government book containing the names of all persons in the service of the state.

Red-breasted, or **Robin, Snipe,** a dowitcher (q.v.).

Red Bug, or **Cotton-stainer.** See COTTON INSECTS.

Red Cedar. See CEDAR.

Red Cloud, Sioux Indian chief: b. about 1818. He first came into prominence as leader of the Indians in the Fetterman massacre near Fort Phil Kearny, Wyoming, in December 1866. In this event 100 men under Capt. Fetterman and Lieut. Brown, comprising the entire command, were slain. Red Cloud then became the acknowledged leader of the warrior Sioux, established a military dictatorship, and terrorized the region over which he ruled. In 1874 the Indians abandoned the North Platte country and went to the Red Cloud agency on the White Earth River, whence they continued under Red Cloud to make frequent raids. In 1880 he made a treaty of peace with the government which he faithfully observed. He died 8 Dec. 1909.

Red Cloud, Neb., city, county-seat of Webster County, on the Republican River, and on the Chicago, Burlington & Quincy railroad; about 110 miles in direct line southwest of Lincoln. It is in an agricultural and stock-raising region. The chief manufacturing establishments are flour mills and machine shops. It has large lumber and stock yards and grain elevators. Its chief shipments are live-stock, wheat, corn, vegetables, and flour. The two State banks have a combined capital of $40,000. Pop. (est.) 1,600.

Red Cross Societies, a general name for those societies founded for assisting the wounded in time of war, so named because their distinctive badge is a red cross on a white ground. Such societies have been established in all civilized countries as a result of an international conference held at Geneva in 1863, which was followed next year by an international convention agreed upon at the same place, at which the International Treaty of Geneva was accepted and signed by a number of different nations. According to this all hospitals and hospital officials, and all in any way engaged in attending the sick and wounded in war, are treated as neutral parties. The society in England has four branches, two ambulance branches, one volunteer nursing branch, and one branch to raise funds and supplies, and societies in other countries. There is an international committee at Geneva which serves as a centre of communication between the different Red Cross societies throughout the world. In connection with this may be mentioned the decoration of the Royal Red Cross instituted by Queen Victoria in 1883, as a reward for women who have exerted themselves in aid of sick and wounded soldiers and sailors in time of war. The enameled crimson-and-gold cross bears the words «Faith, Hope and Charity,» with the effigy of her majesty, the royal and imperial cipher, etc., and is attached to a blue ribbon and worn on the left shoulder.

The first war to bring the Red Cross service into activity was that of 1866 in Germany, Austria, and Italy. Austria had not yet joined the compact, but her citizens raised and gave to the service almost $500,000. Germany's societies supplied over $3,000,000, and 500 volunteers, men and women, entered the service. The Red Cross work during the war proved the incalculable value of the organization. The next call on the service was the Franco-Prussian war. In Germany, more than 2,000 committees were formed at the beginning of the conflict, with a central committee at Berlin. More than $14,000,000 was raised and used. France had less resource in readiness, but she raised and used nearly $2,000,000, and her service cared for more than 100,000 wounded men. The next demand on the Red Cross was in 1876–8, when Turkey, Servia, Montenegro, Greece, and Russia became embroiled. In the beginning of this period of its work, the Red Cross service was regarded with suspicion by the military, but was soon solicited to take control of its treaty-province. It raised almost $17,000,000 and applied over $13,000,000.

The Red Cross emblem found its first opposing force in Turkey. The Turkish soldiers regarded it as of religious significance, and so violent was their prejudice that a red crescent was substituted in order to secure speediest recognition and co-operation. In the Japanese army the Red Cross service has been wonderfully effective. In 1886, Japan entered into this international treaty, and the mikado became president of a Red Cross society in a civil capacity. In the Turko-Russian contest, in the Tunisian, the Tonkin, and the Madagascar wars, the Red Cross was notably active. In the Græco-Turkish campaigns its work and sacrifice were heroic.

National Red Cross.—This is an American body incorporated under the laws of the District of Columbia, 1 Oct. 1881, reincorporated 17 April 1893, and reincorporated by act of Congress, June 1900; for the relief of suffering by war, pestilence, famine, flood, fires, and other calamities of sufficient magnitude to be deemed national in extent. The organization acts under the Geneva Treaty. The United States gave its adhesion by act of Congress 1 March 1882; ratified by the Congress of Berne 9 June 1882; proclaimed by President Arthur 26 July 1882; headquarters, Washington, D. C. The introduction and development of the Red Cross movement in the United States were chiefly due to Miss Clara Barton, the founder of the American branch. Previous to the organization of this branch there were many members of the Red Cross Society in the United States with Miss Barton as their representative. When the national branch was regularly formed Miss Barton was chosen leader. In the United States no laws have been passed to regulate Red Cross work. The national branch has no sub-societies or sub-committees; but patriotic and sympathetic men and women as individuals, or united in societies, are at liberty to assist and to co-operate with the Red Cross in raising money and in providing nurses and whatever the service requires. Whenever needed, this co-operation is active in every State and in most of the Territories.

The American National Red Cross did relief work in the Russian famine of 1892, and in Armenia in 1896.

The Red Cross work in Cuba during the war, as measured by service and contributions, was phenomenal. The total value of gifts, including cash donations, reached nearly $4,000,-

000. When peace was declared, there yet remained starvation, sickness, disease, destitution, and desolation on the island. The Red Cross continued indefatigable in its work. In all its Cuban undertakings volunteer assistance and contributions of supplies were received from France, England, Belgium, Holland, Switzerland, Germany, Italy, Denmark, and Mexico. Almost all the Red Cross work during the war with Spain was done by temporary Red Cross auxiliaries, and other aid societies which went out of existence at the end of the war, and which had little or no connection with the National Society beyond that implied by the name.

National Support.—The governments of the United States, Great Britain, Germany, and Italy give no regular financial support to the Red Cross societies. In 1882 Congress appropriated $1,000 for printing Red Cross literature; and since then, from time to time, has appropriated various sums for special purposes, but otherwise the society has received no financial support from the government of the United States. In Germany the government grants the society permission to hold occasional lotteries to secure funds. France allows an indemnity of 20 cents a day for each sick or wounded soldier cared for by the society in time of war. The Netherlands government pays the salary of the secretary, provides office quarters, allows $400 a year for office expenses, pays the traveling expenses of an officer whose duties in connection with the work of the society may necessitate his leaving his home. Belgium gives financial support in time of war. Denmark contributes annually $1,000. Austria gives $2,400 annually for assistance in case of epidemics or great calamities. Switzerland appropriates $5,000 annually for a special purpose. The emperor and empress of Japan give annually $1,250. Russia pays for men taken care of by the society in time of war, at a rate agreed upon with the minister of war. In 1900 the emperor sanctioned a tax of 2½ cents on certain railroad tickets and $2.50 on passports, such extra tax to be for the benefit of the Red Cross Society. The membership of the society is approximately as follows: In the United States, 298 members of the National Society; France, 55,000; Austria, 52,209; Hungary, 42,041; Japan, 894,814; Germany, main branch and affiliated societies, 300,000. In several other countries the society is well organized, with a large number of physicians, nurses, and general equipment.

Consult: ‹Red Cross Society in Foreign Countries.› Senate document No. 178 (1903–4); Du Camp, ‹La Croix-Rouge de France›; Criegen, ‹Das Rothe Kreutze in Deutschland›; Barton, ‹History of the Red Cross›; ‹History of the Red Cross in Peace and War›; quarterly bulletin published by the International Committee of Geneva, ‹Bulletin International des Sociétes de la Croix-Rouge›; ‹Memorial des Vingt-cinq premières années de la Croix-Rouge›; American Red Cross Relief Reports (New York).

Red Deer, or **Stag,** the common deer (*Cervus elephas*) of Europe and western Asia, which is typical of the family, and the ordinary «deer» of literature and poetry as well as of the chase. It much resembles the American wapiti, but is smaller and rather darker in general color. A fine specimen will stand four feet tall at the fore-shoulder and will weigh about 300 pounds, but exceptional ones have weighed much more. Even larger are those of the Asiatic border and Asia Minor. The antlers of Scotch and Irish stags rarely exceed 33 inches in length; but those of eastern Europe and Siberia are far longer. Several different names have been given to the related deer of northern Asia, but they seem to be essentially the same as those of Europe, where they survive sparsely and under legal protection in almost all the countries. In the British Islands the wild red deer remains only in the Highlands of Scotland, but is «preserved» on many large estates and protected moors in both England and Ireland. The species is supposed to have been originally introduced into England from France, where it became very numerous, but since the 17th century it has been killed off in most parts of that kingdom to make way for the fallow deer, the venison of which is far superior, and the animal itself of a more manageable and placid disposition.

The stag has a fine eye, an acute sense of smell, and a good ear. When listening, he raises his head and erects his ears. When going into a coppice or other half-covered place, he stops to look round him on all sides, and scents the wind, to discover if any object be near that might disturb him. Though a simple, he is a curious and crafty animal. When hissed or called to from a distance, he stops short, and looks steadfastly, and, with a kind of admiration, at horses or men; and if the latter have neither arms nor dogs he moves on without betraying any symptoms of alarm. He eats slowly; and after his stomach is full, he lies down and ruminates at leisure.

In winter and spring this animal rarely ever drinks, the dews and tender herbage being sufficient to satisfy his thirst; but during the parching heats of summer, he not only frequents the brooks and springs, but searches for deep water wherein to bathe and refresh himself. He swims with great ease and strength, particularly when he is in good condition, his fat contributing to his buoyancy. His voice is stronger, louder, and more tremulous in proportion as he advances in age; and during the rutting season it is really fearful. The cry of the hind, or female, is not so loud as that of the male. The pairing season is in August; the time of gestation is between eight and nine months; and she seldom produces more than one at a time. The usual season of parturition is about May, and at that season the hinds are very cunning in concealing and tending, and exceedingly courageous in defending their young, which are exposed to many enemies. The «calf» (as the fawn is called by gamekeepers) never quits the dam during the whole summer; and in winter, the hind, together with all the males under a year old, assemble in herds, which are more or less numerous in proportion to the mildness or severity of the season. At the approach of spring they separate, none but those of the age of one year remaining associated. Stag-hunting, as carried on in the Highlands, is a sport capable of rousing all the manly ardor and energy of youth and manhood. The beauty, graceful and magnificent bearing of the animal, his sagacity in evading the stratagems of the hunter, or deer stalker, and his courage when at bay, add greatly to the pleasure of the chase. When the stag stands at bay, his effort is to do so in a river or lake, where he has a great advantage over the dogs, for he firmly stands and holds his position, whilst they swim powerless around him. On land, even, a stag at bay has great advantage over the hounds, who exhaust themselves with their clamor, while he is in a comparative state of rest, and recovers his wind. In stalking deer, the animal is generally shot; but if he is only wounded, and has power to fly, then the dogs are slipped to the pursuit. But, in olden times, the chief reliance for pulling and killing the deer was in the dogs; and the fleetness and courage of their hounds were the pride of nobles and kings.

At the present day another sort of stag hunting takes place near Windsor Castle, and in some other parts of England. In this sport, which is contemptuously regarded by many persons, a captive stag is carried in a covered cart to the place where the chase is to occur, and then turned loose. After a brief interval, called giving the deer «law,» a pack of hounds is sent upon his trail, and if the stag has spirit enough to run, the hunters following on horseback have a lively chase across the country, at the end of which the deer is retaken, unharmed if possible, and saved to run another day. This is a rather tame tradition of the ancient sport.

From the most remote periods, the stag has been the favorite object of the chase; and the severe forest laws of the earlier Norman monarchs sufficiently attest the importance which they attached to the sport. The afforesting of vast tracts of country, by which not only single cottages were destroyed, but whole villages swept away, and churches desecrated and demolished, was the fertile source of misery to the poorer inhabitants, and of injustice to the ancient proprietors of the soil; and the cruel inflictions of the oppressive laws which were enacted to preserve the deer, increased tenfold the curse arising from this tyrannical passion for the chase,— for it was a crime less severely penal to kill a man than to destroy or take a deer.

The ancient customs and laws of ‹Venerie,› that science which our simple ancestors looked upon as one of the first accomplishments of the high-bred noble, and a knowledge of which was essential to his education, were formal and technical to an extreme degree. A few of the terms, betokening the different ages of the stag and hind, are still retained, though somewhat altered. The young of either sex is called a «calf»; after a few months the male becomes distinguished by the growth of the bossets, or frontal protuberances, on which the horns are afterward developed, which during the first year are merely rounded knobs, whence he takes the name «knobber.» In the second year they are longer and pointed, and are called dags, and the animal has now the name of «brocket.» In the third year, the first, or brow antler, has made its appearance, and the deer becomes a «spayad.» In the fourth, the bez-antler is added, and he is then termed a «staggard.» He is a «stag» in the fifth year, when the third antler, or royal, appears; and in the sixth, the commencement of the sur-royal, or crown, is formed; when he takes the name of «hart,» which name he retains through life. At this time he is called a «stag of ten,» probably because the branches, including the sur-royal, frequently amount to that number. After the seventh year he is said to be croched, or palmed, or crowned, according to the number of branches composing the sur-royal. The female is a «calf» in the first year, a «brocket's sister» in the second and third, and ever afterward, a «hind.»

See DEER, and consult authorities there cited.

Red Eagle, Order of the. See ORDERS, ROYAL.

Red-eyed Vireo. See VIREO.

Red Game, or Grouse. See GROUSE.

Red Gum-tree, one of the Australian Eucalypti (*Eucalyptus resinifera*), yielding a gum-resin valued for medicinal uses. (See EUCALYPTUS.) Also the North American liquidambar (q.v.).

Red Horse, a fish. See SUCKER.

Red Jacket, American Indian, chief of the Senecas: b. Old Castle on Seneca Lake, about 1751; d. Seneca Reservation 30 Jan. 1830. His Indian name was Sagoyewatha; he was called Red Jacket on account of the scarlet jacket he always wore, which had been given him by a British officer. He was one of his tribe who served with the British during the Revolutionary War; and was noted as an orator. He became widely known through his attitude toward the treaty of Fort Stanwix in 1784; a council had been called to negotiate between the United States and the Six Nations for the cession of lands, and on the occasion he spoke eloquently against the proposed treaty, but without avail. It was shortly after this that he was elected chief of the Senecas. In 1792 on the occasion of the signing of a treaty of peace between the United States and the Six Nations, Red Jacket had an interview with General Washington, who gave him a silver medal which he always wore afterward. In 1810 he gave information to the agent of the government of the attempt made by Tecumseh to draw the Senecas into the western combination; and in the war with England of 1812 he offered the service of his tribe to the United States, and proved his bravery in several skirmishes. The latter years of his life were passed on the Seneca Reservation; he became very intemperate, and was at one time deposed from the chieftainship on that account. He always opposed the advance of civilization, the missionaries, and the work of education among his people. Consult the ‹Life› by W. L. Stone.

Red Jacket, Mich., village in Houghton County; on the Chicago, M. & St. P., the Chicago & N., the Mineral Range, and the Copper Range R.R.'s; about 15 miles north of Houghton. It is in the famous copper region in northern Michigan, near Lake Superior. Its industries are connected with the mining of copper and preparing it for market. Pop. (est.) 4,700.

Red Line Map, a map which attracted considerable interest about the time of the dispute between the United States and England over the boundary line between Canada and Maine. It was made by the Frenchman D'Anville in 1746. It had been sent to Vergennes, the French minister, by Franklin in 1782, and was discovered among the Paris archives by

Jared Sparks. A strong red line drawn near the ridge, in which the Kennebec and Penobscot rivers rise, more than favored the English claims, respecting the northeast boundary of the United States. Sparks sent it to Webster, then Secretary of State, who was anxious lest the English should hear of it. It was used in a secret session of the Senate, and with the Maine commissioners to induce a ratification of the treaty, and was afterward made a ground of reproach against Webster by opponents of the treaty.

Red Men, Improved Order of. See IMPROVED ORDER OF RED MEN.

Red Oak, Iowa, city, county-seat of Montgomery County; on the Nishnabatona River, and on the Chicago, Burlington & Quincy railroad; about 48 miles southeast of Council Bluff and 38 miles east of the Missouri River. It was founded in 1857. It is in a fertile agricultural and stock-raising region; and its industries are connected chiefly with farm products. The chief industrial establishments are flour mills, machine shops, creameries, lumber and brick yards, and stock yards. The city has 13 churches, six school houses, county court-house, municipal buildings, and several good business blocks. The three banks have a combined capital of $200,000. Pop. (1890) 3,321; (1900) 4,355; (1910) 4,830.

Red River, a large river of the United States, the southernmost of the great tributaries of the Mississippi River. Its headwaters are in the northwestern part of Texas, on the eastern edge of the Llano Estacado, and it flows east-southeast, forming the boundary between Texas and the Indian Territory and the northeastern boundary of Texas, entering Arkansas at the southwest corner of the State. After entering Arkansas it turns south and pursues an exceedingly irregular course to Shreveport, La., where it again takes a southeast course to Avoyelles County, making a large northern curve in crossing this county, and entering the Mississippi River opposite the southwest corner of the State of Mississippi. The mouth of the Red River is about 340 miles from the mouth of the Mississippi River. The whole course is nearly 2,000 miles. The chief tributaries are the Washita, which joins it in Louisiana; and the False Washita and the Kiamich, both of which it receives in the Indian Territory. Much of its course is through rich prairies, with red soil which colors the water. About 100 miles above Nachitoches, which lies 100 miles above the mouth of the stream, commences a swampy expansion of the river called the Raft, 70 miles long and 20 miles to 30 miles wide, produced by the river dividing into a number of channels, sometimes shallow, which have been obstructed by fallen trees and other matter brought down by the stream. At great expense this obstruction has been cleared away so far as to admit the passage of steamboats. About four miles above Natchitoches the various channels again unite, soon, however, again to separate into numerous creeks and bayous. Above Shreveport was another such Raft, about 32 miles in length. In 1873 a channel was cut through, making this part of the river navigable, but constant care is exercised in removing the floating timber so as to keep the stream open. In the upper part of its course it flows through lofty cañons whose perpendicular sides are from 300 to 800 feet in height. After leaving the cañons it enters the sandy lands, where the waters extend out to a shallow stream from 500 to 3,000 feet in width. Then as it enters the wooded country the stream becomes sluggish and spreads out for miles.

A peculiarity of the lower course of the river is the bayous which it sends out. Some of the bayous return to the main stream and others flow directly to the Gulf of Mexico. The Atchafalaya River originally left the Mississippi at a great bend below the mouth of the Red River; but the Mississippi has cut across the bend, forming Turnbull Island, and here the Red occupies the channel once the Mississippi, and flows south of the island, so that the head of the Atchafalaya is now in the Red River, from which it flows south to the Gulf. The Mississippi receives the flood much earlier than the Red River, and at that time, the Mississippi flood waters flow back past Turnbull Island and down the Atchafalaya. The flood plain of the Red River in Louisiana extends along the river until it is merged into the flood plain of the Mississippi at the mouth of the Black River. This plain is from 10 to 20 miles wide, and is known as the Red River bottoms. The plain is below the level of the river and is protected by levees. The river bed above Natchitoches has changed. Many years ago the river left the old bed and cut a new way for itself, a channel about 20 miles long. The new channel is called Bon Dieu River and the old channel is called Cane River. The government is improving the navigation of the Red River. Engineers are working to force all the waters of the Red River into the Mississippi; thus cutting off Atchafalaya. The river is navigable for nearly 1,300 miles, and with its tributaries, over 2,000 miles. Small steamers can ascend almost to the Texas boundary at high water, and to Shreveport at all seasons except when the water is very low. Consult: Marcy, ‘Exploration of the Red River of Louisiana.’

Red River, or Song-Koi, a river of Tongking, formed by the junction of the Leteën and Song-shai, the former rising in the Yun-nan province of China, the latter in Laos. It flows southeast, passes Hanoi, and after a course of about 700 miles falls by several mouths into the Gulf of Tongking. The river is navigable to Lao-kai, on the border of China and Tongking and along it the French are developing a trade with the Chinese.

Red River Campaign. In 1864 Gen. Banks, to reduce Texas, asked for reinforcements in order to take in rear the Confederate works at Galveston and the mouth of the Brazos; but Halleck advised operating by way of the Red River, capturing the Confederate depot and dockyard at Shreveport, and repossessing western Louisiana and Texas at a blow. The Mississippi squadron under Porter was to co-operate; the army must be back for the trans-Mississippi operations of spring and summer; but no movement could be made till the spring rains had raised the Red, with only four feet at low water and full of obstructions. The fleet left Vicksburg 10 March, and landed A. J. Smith's troops at Simsport on the 13th; Gen.

Franklin had already come up and driven Gen. Dick Taylor from Fort De Russey guarding the stream; the fleet passed up without opposition; and on the 15th and 16th the forces met at Alexandria. But the Union movements were difficult of co-ordination; Banks did not arrive till the 26th, the rest of Franklin's corps on the 28th. Meantime the Confederates had strongly fortified Shreveport and placed several gunboats there. Banks, with Franklin, went by land to Natchitoches, routing a Confederate force at Cane River on the 28th; Smith's command went by the river in transports, to Grand Ecore, four miles below, arriving 3 April, the day after Banks. On the 8th and 9th Banks advanced by a road away from the river; the Confederates had laid a V-shaped ambush for him, and his command of 8,000 men was utterly routed, and would have been annihilated but for reinforcements from Franklin, 2,000 being killed or wounded (battle of Mansfield). Banks retreated; the next day the Confederates advanced, but were met by a counter-ambush of Franklin's, and one wing of their army was driven back with heavy loss. But the other wing was so successful that the Federals retreated that night and hurried on to Grand Ecore and finally to Alexandria, abandoning the campaign. Meantime the fleet was caught in the falling water of the Red, and would have fallen into the hands of the Confederates but for the engineering skill and resolution of Lieut.-Col. Joseph Bailey, who built a dam of stones and logs, which raised the river and floated all the vessels down with a narrow escape from destruction.

Banks' army in this campaign numbered 31,303; but after detaching two divisions sent to different points, he had a marching column of 25,736 officers and men of all arms. His losses, including those lost on the retreat from Alexandria, were 454 killed, 2,191 wounded, and 2,600 captured or missing, a total of 5,244. Taylor's Confederate army numbered 11,000, and its total losses in the campaign were 3,976 in killed, wounded, and missing. See SABINE CROSS ROADS.

JOSEPH T. DERRY,
Author of 'History of Georgia.'

Red River of the North, a stream which has its source among the lakes in the west central part of Minnesota. It first flows south and southwest, then west to the boundary between Minnesota and North Dakota, where it turns north and forms the boundary between the States mentioned. It enters Canada in the province of Manitoba and flows into Lake Winnipeg. Its source is about 1,600 feet above sea-level and its mouth 710 feet. It is nearly 700 miles long, the greater part of its course is in the United States. Its drainage area is about 43,500 square miles, three fourths of which is in the United States. It is navigable almost to the source. The river and its tributaries have in many parts of the plain cut channels through the clay from 20 to 30 feet deep. The Red River is connected with the Mississippi through its southern branch, Lake Traverse, and the Minnesota River. At high water small steamers can pass from the Red River to the Mississippi. It is connected with Hudson Bay by means of Lake Winnipeg. A number of small rivers enter the Red River from Minnesota and North Dakota. The largest tributaries from North Dakota are Sheyenne and Pembina. The latter river has its rise in Manitoba. The chief tributary it receives in Manitoba is Assiniboine.

The Red River flows through a productive agricultural region, famous for the quantity and quality of its wheat. The greater part of the basin of this river has been twice submerged beneath the sea, and it was covered with an extensive glacial drift which left an immense lake, now called Lake Agassiz (q.v.), that had an outlet to the Mississippi River. The beaches are still well defined, even those showing the gradual contraction of the lake. The lakes of Manitoba are the remains of this vast lake. The deposits made by means of ice and water have made the Red River Valley an exceedingly fertile region.

Red River Settlement, Canada, founded in 1812 by the Earl of Selkirk, on the banks of the Red River, and since 1870 forming part of the province of Manitoba (q.v.).

Red Rover, The, a sea tale by James Fenimore Cooper, published in 1828.

Red Russians. See RUTHENIANS.

Red Sandstone, an obsolete term in stratigraphical geology, used to designate a group of formations of which a red sandstone of various shades was characteristic. These sandstones, however, were later found to belong to two series, a lower one, the Old Red Sandstone (q.v.), now generally known as Devonian, and an upper one, the New Red Sandstone (q.v.), separated from each other by the formations of the Carboniferous Period (q.v.).

Red Scale, an insect affecting the orange (q.v.). See also SCALE-INSECTS.

Red Sea, or **Arabian Gulf** (ancient, *Mare Rubrum, Mare Erythræum,* or *Sinus Arabicus;* Arabic, *Bahr-el-Hejaz*), a branch of the Indian Ocean, extending from the Strait of Bab-el-Mandeb, in a north-northwest direction between Arabia on the east, and Abyssinia, Nubia, and Egypt on the west, and connected with the Mediterranean on the north by the canal, about 100 miles long, across the Isthmus of Suez. The Red Sea is a comparatively narrow expanse, 1,450 miles long with a maximum breadth on the tropic of Cancer of 200 miles and a general average of about 180 miles, but diminishing gradually at its south and north extremities; at the former, across the strait it has a width of only 14½ miles, further subdivided by the island of Perim into two channels, a larger on the east, of 11 miles, and a less on the west, of 1½ miles, and forking at the latter into two branches, the one of which, forming the Gulf of Akaba, penetrates north by east into Arabia for about 100 miles, with an average breadth of about 15 miles; while the other, forming the Gulf of Suez, follows the general direction of the sea, and penetrates between Arabia and Egypt for about 200 miles, with an average breadth of about 20 miles. In the fork between these two branches is the celebrated Mount Sinai, or Jebel Musa (Mount of Moses). To the Biblical student the Red Sea possesses considerable interest, from the account of its miraculous passage by the children of Israel when journeying from Egypt. The place at which they crossed the sea was the Gulf of Suez at its northern extremity, but opinions differ as to the exact point of transit, some maintaining that it was in the neighborhood of the town of Suez, and others that it was about 18 miles farther south, at the mouth of the Wady Tuarik.

The climate is tropical and depressing; both shores of the Red Sea east and west consist generally of a low tract, mostly sandy, though sometimes swampy, varying in width from 10 to 30 miles, and suddenly terminated by the abutments of a lofty table-land of 3,000 feet to 6,000 feet high. The Red Sea may thus be considered as occupying the bottom of an immense longitudinal valley, which probably at one time extended between the table-lands without interruption, but has since been partially filled up by coral-workings, which, extending in parallel lines at a short distance from either coast, have subdivided the sea into three different channels, and have also studded its shores with numerous small islands. In the main channel the depth reaches in one place 1,054 fathoms, but diminishes toward the extremities, where the depth in general does not exceed from 40 to 50 fathoms.

In the Gulf of Suez, which in earlier times is supposed to have extended considerably farther north, this depth gradually decreases to 30 fathoms, and still continues to shoal, till at the harbor of Suez it amounts to only three fathoms; in the Gulf of Akaba, on the contrary, the depth of the main channel is fully maintained, and in some places even exceeded. The currents of the Red Sea are the result of prevailing winds. These winds, whether proceeding either directly north or south, affect only the main body of the sea, and leave a considerable belt along the coasts subject to alternations of land and sea breezes, and not unfrequently to sudden squalls. The chief dangers to navigation arise from the number of shallow reefs, of the presence of which no intimation is given, as the sea never breaks upon them. This absence of breakers is accounted for by the porous nature of the coral, which offers so little resistance that the sea diffuses through it without commotion, as if it were passing through a sieve. The principal harbors of the Red Sea are, on the African coast, Suez, Kosseir, Suakin, and Massowa; and on the Arabian coast, Jedda (the port of Mecca), Hodeida, and Mocha. The trade from shore to shore is not of much importance, consisting chiefly of the transport of pilgrims and some grain from Egypt; but the trade up and down the sea, between Europe and the East Indies, has become very large since the construction of the great ship canal across the Isthmus of Suez.

A telegraphic cable enters the Red Sea at Suez, passes down to Kosseir on its western shore, thence to Suakin on the same side, about lat. 19° 10′ N., and then proceeds in a south-southeastern direction close to the island of Perim, and out into the Indian Ocean by the Strait of Bab-el-Mandeb, and arrives at Aden (q.v.).

Red Shirts, the name given to an organization in North Carolina, whose object was to establish and maintain white supremacy in that State, and keep the negroes under. It flourished in the reconstruction period after the Civil War. The members wore red shirts.

Red-shouldered Hawk, a large American buzzard-hawk (*Buteo lineatus*), known popularly as one of the hen-hawks (q.v.), and common over most of North America; but western examples differ from the eastern ones and are called the red-bellied hawk (variety *elegans*). It is most numerous south of the Great Lakes in winter, by reason of the accession of northern migrants. It is of large size and distinguished by the rufous tinge of the head, neck, and shoulders, and plumage generally, the breast with shaft-streaks of blackish, and the tail clear brownish-black, crossed with six sharply defined narrow bands of white. The young are darker and more obscurely marked. The habits of this bird are much like those of its congeners, the red-tail, and broadwing. They may be seen at all seasons «sweeping in graceful curves over the country, rising and falling in spirals, unless after noting prey, when they sometimes dart down hundreds of yards in a very few seconds. Although they feed much on birds and rabbits, and are frequent visitors to the farmyard, they seem to have a special predilection for squirrels.» They make their nests of sticks in the tops of tall trees, and very early in the spring four or five large, globular, heavily blotched eggs, are laid. Consult Fisher, 'Hawks and Owls of the United States' (1893).

Red Snapper, a fish. See SNAPPER.

Red Snow, the color of which is caused by minute organisms, vegetable or animal. Aristotle hinted at its existence; Saussure in 1760 discovered it on the St. Bernard, and Capt. Ross in 1819 brought specimens from the Arctic regions. He had found eight miles of cliffs, 600 feet high, colored by it, in many places to the depth of 12 feet, where the rock was reached. Capt. Parry and other Arctic explorers have since met with it abundantly.

Red Spider, a small, scarlet web-spinning mite (*Tetranychus telarius*), which damage the leaves of plants in greenhouses. They should be killed off by a kerosene emulsion spray.

Red Sorrel. See HIBISCUS.

Red Stone, Old Fort, a Pennsylvania structure which figured in the struggle between the French and English for mastery in the Ohio region. It was first a storehouse of the Ohio Company, was a rendezvous for the English when they gathered to advance against the French in 1754, and was burned by the French later in the conflict. At its ruins the leaders of the Whiskey Insurrection held a meeting in August 1794 to plan opposition to the whiskey tax.

Red Sunsets, brilliant phenomena which attracted attention in North America and other parts of the globe in the autumn of 1883 and for several succeeding months. A vivid red glow suffused the entire western sky, remaining for upward of an hour, when it would slowly fade away. This strange sight was first noticed in India, where, it is said, the sun assumed a distinct greenish tinge on nearing the horizon. In striving to account for these strange manifestations a number of solutions were offered, but the theory that met with greatest acceptance was that they emanated from volcanic dust and gaseous matter vomited by Krakatoa, in Sunda Straits. Calculations demonstrated the fact that the manifestations of the red glow coincided with the course which such vapors would take on being wafted away by winds.

Red Tape, a term applied to unnecessary routine and formality in official affairs. It is derived from the fact that official documents were bound together by red ribbons or tapes. Dickens in 'Little Dorrit,' and Mark Twain, in one of his humorous sketches, have illustrated the working of red tape.

Red Water, (1) a disease of cattle. See RINDERPEST. (2) A marine worm of flagellate protozoa, class *Mastigophora*, order *Dinoflagellata*, infecting harbor waters, destroying fish and molluscs. Varies in color from yellow to reddish brown and is so called as it turns the water red when present.

Red Wing, Minn., city, county-seat of Goodhue County; on the Mississippi River, at the head of Lake Pepin, and on the Chicago, Great Western, the Chicago, M. & St. P., and the Chicago & N. R.R.'s; about 40 miles southeast of Saint Paul. It was settled in 1853, incorporated in 1854, and chartered in 1864. It is in a productive agricultural region in which are deposits of fire-clay. Red Wing is the commercial and industrial centre for a large part of Goodhue and Dakota counties. The chief manufacturing establishments are sewer-pipe works which employ about 450 persons; furniture factories, about 250 employees; lumber mills, 140 employees; stoneware works, 120; hat factory, 40; other manufactories, with about 130 employees. The prominent public buildings are the churches, schools, and several business blocks. The educational institutions are a State training school, Red Wing Seminary, Hague Synod Theological School, Lutheran Ladies' Seminary, high school, public and parish schools, a public library, and private school libraries. There are two hospitals. The three banks have a combined capital and surplus of $375,000. The government is vested in a mayor and a council of nine members, elected biennially. Pop. (1890) 6,294; (1900) 7,525; (1910) 9,048.

JOHN A. PARDEE,
Editor, 'Goodhue County News.'

Redan', a fortified work having two faces forming a salient angle in the direction from which an attack may be expected. It is open at the gorge. A double redan has a re-entering angle for mutual defense. The redan is the simplest field work, and is used for defending the avenues of approach to a village, bridge, or defile. In front of another field work, it is called a flèche. When flanks are added to the faces, the work becomes a detached bastion or lunette. The redan at Sebastopol in the Crimean war was the scene of stubborn conflict between the Russians and the English.

Redbird. See CARDINAL GROSBEAK.

Redbreast, or **Robin Redbreast,** a familiar European warbler (*Erythacus rubecula*), which by its familiar habits has endeared itself. to children, and has caused it to be protected and welcomed more than any other bird. The red breast of the male is the distinguishing feature of the species, but the females have duller colors. In Great Britain the redbreast is a permanent resident, but in more northern countries it is migratory, flying southward in winter. It also occurs in Asia Minor and in North Africa. The nest is made of moss and leaves, and is lined internally with feathers. The eggs number five or six, and are white, spotted with pale brown.

These birds, in winter especially, become very bold and confident in habits, approaching doors and windows without fear, and soon learning even to know the hand which deals out crumbs and scraps of food to them during the inclement season. On the approach of the milder spring the redbreast returns to its native haunts and wilder state. During the breeding season these birds are very pugnacious, and they may attack and drive away all the smaller birds from the vicinity of the nest. The food in spring consists chiefly of insects, while in autumn fruits and seeds constitute the dietary. The song is sweet, but not specially remarkable, and continues during spring, summer, and autumn, often in rainy weather. In Germany it is termed *Thomas Gierdet;* and in Norway, *Peter Ronsmad.*

Redbuck. See DUIKER-BOK.

Redbud, a tree. See CERCIS.

Redcap, a variety of Hamburg fowls. See POULTRY.

Red'ding, Cal., city, county-seat of Shasta County; on the Sacramento River, and on the Southern Pacific railroad; about 172 miles north of Sacramento. It is in a mining and lumbering region, in which there are some excellent farms in the fertile valleys. The chief industrial establishments are lumber mills, machine shops, foundries, and tool shops. The shipment trade is chiefly in lumber and minerals. It has a well-built court house and a sanatorium. Pop. (1910) 3,090.

Redemp'tion, in Christian theology, the liberation of sinners from the penalties of the violated divine law; it is effected through the expiating vicarious sacrifice of Christ upon the cross. In law, the freeing of an estate from mortgage, or the taking back of mortgaged property upon fulfilling the terms or conditions on which it was conveyed to the mortgagee. See EQUITY OF REDEMPTION.

Redemp'tioners, or **Indentured Servants,** emigrants to the American colonies who sold their services to planters or others for a term of years — four, five, or seven, according to the contract — after the completion of which they acquired their liberty with a grant of land. There were redemptioners in the first colony founded in Virginia; the system was introduced in Massachusetts in 1631 and later in Maryland, New York, Connecticut, and Pennsylvania. With these indentured servants were brought in many persons who came not of their free will but were kidnapped and held in servitude. See VILLEINS.

Redemptionists. See TRINITARIANS.

Redemptoris'tine Nuns, or **Order of the Most Holy Redeemer,** a religious order of women in the Roman Catholic Church, founded in 1732 by St. Alfonso de Liguori. They are strictly cloistered, leading the contemplative life, and by their prayers assisting the missionary priests of the order of Redemptorists (q.v.); they are subject to the jurisdiction of the ordinary of their place of residence.

Redemp'torists, members of the Congregation of the Most Holy Redeemer, an institute of missionary priests in the Roman Catholic Church, founded in 1732 by St. Alfonso de Liguori; in some countries they are known as Liguorians. The institute received the approval of Benedict XIV. in 1749. The members, in addition to the three perpetual vows of poverty, chastity, and obedience common to all monastic and semi-monastic bodies, bind themselves by a vow of perseverance in the institute until death: by their vow of poverty they are bound to refuse all church benefices, offices, and dignities outside of their congregation. Their main occupation is the apostolic ministry in conducting «retreats» and «missions» to all classes, with preference for such as are most neglected or who come least under the ordinary ministrations of the Church. The Congregation has establishments in various countries of continental Europe and many in the British isles. Their first house in the United States was founded in 1832 at Detroit: they have now houses in many of the principal cities.

Redeye, the name of two or more common fresh-water fishes: (1) the rockbass or goggle-eye (*Ambloplites rupestris*) (see Bass); (2) in England the rudd, a reddish roach-like fish (*Leuciscus erythropthalmus*), sometimes two pounds in weight, and highly esteemed by anglers both in Great Britain and on the Continent.

Red′field, Isaac Fletcher, American jurist: b. Wethersfield, Vt., 10 April 1804; d. Charlestown, Mass., 23 March 1876. He was graduated from Dartmouth College in 1825, admitted to the bar and engaged in law practice. He was attorney-general for Orleans County, Vt., in 1832–5, judge of the Vermont supreme court in 1835–52, chief justice in 1852–60, and in 1857–61 occupied the chair of jurisprudence at Dartmouth. He removed to Boston in 1861, and in 1867–9 was special counsel in Europe for the United States. He was editor for New England of the ‘American Law Register’ and published: ‘Law of Railways’ (1857); ‘Law of Wills’ (1864–70); ‘Leading American Railway Cases’ (1870); etc.

Redfield, William Charles, American scientist: b. Middletown, Conn., 25 March 1789; d. New York 12 Feb. 1857. In 1803 he was apprenticed to a mechanic at Upper Middletown (now Cromwell), in 1811 set up for himself at Middletown as a mechanic and small merchant, and in 1821 began his study of the subject of Atlantic gales by observations of the region in eastern Connecticut and western Massachusetts devastated by the storm of 3 September, long known as the «great September gale.» By his investigation of the course and direction of prostrated objects, he became convinced that the storm was a progressive whirlwind. The perfecting of his theory of storms became his chief object. In 1831 he began the publication in the ‘American Journal of Science’ of a series of articles on the laws of storms; and in 1834, in an article in the same journal on ‘Hurricanes of the West Indies’ gave a complete synopsis of the main points of his theory as developed by a more extensive analysis of observed phenomena. His views, known as the «rotary theory of storms,» were accepted after some slight opposition; and Redfield, by his explanation of the mechanism of extended hurricanes became one of the principal contributors to a scientific knowledge of the earth's atmosphere. He wrote also on geography and geology. As a naval engineer he devised the system of «safety barges,» by which passenger service via the Hudson between New York and Albany was conducted by means of a passenger boat drawn by two steamers at such a distance as to avoid danger of explosions, the frequent occurrence of which had caused general terror. Thus originated the idea of tow-boats for the conveyance of freight. Redfield was also prominently interested in railway construction. A list of his published papers, from 1829 to 1857, includes 62 titles.

Redfield, S. D., city, county-seat of Spink County; on the Chicago, M. & St. P. and the Chicago & N. R.R.'s; about 35 miles south of Aberdeen. It is an agricultural and stock-raising region. It has a State Institution for the Feeble-Minded and the Redfield College, opened in 1887 under the auspices of the Congregationalists. Pop. (1910) 1,431.

Redfin. See Red-horse; Shiner.

Redfish, the name of several fishes notable for their color: (1) In Alaska, the salmon more familiarly known by its name «blueback» (q.v.) in the Columbia River Valley; also called redfish about the lakes of northern Idaho. (2) On the California coast, a gaudily tinted wrasse (*Pimelometopon pulcher*), related to the eastern tautog, which reaches a weight of 12 or 15 pounds, and is taken in large numbers in the kelp offshore with hook and line. The Chinese salt and dry them. (3) The rose-fish (q.v.) of the Atlantic coast. (4) The red drum. See Drumfish.

Redgauntlet, rĕd-gänt′lĕt, a novel by Sir Walter Scott, published in 1824. Sir Alberick Redgauntlet, ardently espousing the cause of the Young Pretender in 1745, pays for his enthusiasm with his life. His widow, ascribing her bereavement to the politics of the Redgauntlets, desires to rear her children in allegiance to the reigning dynasty. Her efforts prove ineffectual and the tale is concerned with the plots to enthrone the Chevalier, into which young Redgauntlet is hurried by his uncle, an ardent Jacobite. Though showing haste, the story does not flag in interest, and even the minor characters — notably Peter Peebles, the crazy litigant, Wandering Willie, the vagabond fiddler, and Nanty Ewart, the smuggler — are living and individual.

Red′grave, Richard, English painter: b. Pimlico, London, 30 April 1804; d. London 14 Dec. 1888. After studying at the Academy, he was elected an A.R.A. in 1840, an R.A. in 1851. From 1847 he took a prominent part in art instruction, and in 1857 was appointed inspector general of art schools, which office, with that of surveyor of the royal pictures, he resigned in 1880. His principal pictures include ‘Gulliver on the Farmer's Table’ (1837); ‘The Daughter of the Reduced Gentleman’ (1840); ‘The Return of Olivia’; and ‘Country Cousins.’ He wrote, with his brother, ‘A Century of English Painters’ (1866), and edited several valuable catalogues.

Redhead, a duck (*Aythya americana*), related to the pochard and canvas-back (qq.v.). From the latter the redhead may be readily distinguished by its much shorter, broader, more strongly hooked bill, and brighter chestnut head, though it is frequently sold to the uninitiated as the more expensive canvas-back, to which it is little inferior in flavor. It is found in North America generally, breeds from the northern tier of States to high latitudes, and winters in Chesapeake Bay and southward. The nest is built of reeds, etc., with a lining of down and either on the ground or on a platform of reeds in the water; the seven or eight eggs are buff-colored and unmarked. Eastwardly this is one of the commonest species of ducks and congregates in great numbers in the sounds and estuaries of the Atlantic coast, consorting with canvas-backs, scaups, and other species of generally similar habits. It feeds on various aquatic animals, but more particularly on water celery and other aquatic plants. In the interior about the Great Lakes and elsewhere, these birds usually appear in flocks for a short time during the migrations and are said to visit the woods for the purpose of feeding on acorns and other mast like the wood-duck. The redhead is perhaps the best known and generally appreciated by gunners of all our ducks, but there is nothing especially distinctive of the method of its pursuit. Consult: Grinnell, ‹American Duck Shooting› (1901); Job, ‹Among the Waterfowl› (1902).

Reding, Aloys von, Swiss patriot: b. Schwyz, Switzerland, 6 March 1765; d. there 5 Feb. 1818. He became captain-general of his native canton in 1788, and defeated the French republicans at Morgarten Pass in 1798. In 1802 he founded a league in the eastern part of Switzerland with the purpose of re-establishing the old federal constitution, but was thwarted by French interference. In 1803 and in 1809 he was elected chief magistrate of Schwyz.

Redlands, rĕd'lạndz, Cal., city in San Bernardino County; on the San Bernardino & R., the Atchison, T. & S. F., and the Southern Pacific R.R.'s; about 65 miles east of Los Angeles. It was settled in 1881 and in 1888 was incorporated. It is on the foothills of the San Bernardino Mountains, in a region famous for its scenic beauty. It is in a fruit section noted for its oranges. Fire-clay is found in the vicinity. The principal manufactures are clay and lumber products; and the trade is chiefly in oranges, raisins, and other fruits, wheat, barley, brick, lumber, and building stone. It has Saint Ursula's Academy, a Union High School, public and parish schools, and the A. K. Smiley Library. Two parks add to the attractions of the city. The government is vested in a board of trustees. They hold office four years. Pop. (1910) 10,449.

Redleg, one of the best known of Old World partridges (*Caccabis rufa*), which is especially numerous in France, where it is the principal object of sport in the autumn. It has been introduced into England, but is not much liked because slow to fly, running speedily before the dog and so puzzling both the dog and the gunner trained to the different behavior of the British gray partridge. Several other species of the genus share the name, as the Barbary partridge (*C. petrosa*) of North Africa, the chukar (*C. chukar*) of India, etc. See PARTRIDGE.

Redmond, rĕd'mŏnd, **John Edward,** Irish political leader: b. Dublin 1851. He was educated at Trinity College, Dublin, studied law and was admitted to the bar. In 1876 he was elected a member of the House of Commons, and later held a position in the vote office. In the House he became a «whip» for the Irish party, and was one of the most active supporters of Parnell in his organization of the Irish Nationalist party. He made several trips to the United States and Canada in behalf of the Nationalists. When the party was divided over the question of the continuance of Parnell's leadership, he supported Parnell. In 1900, when the factions were united, he was made the leader of the united party, which he has effectively organized. He is both a skilled parliamentarian and an eloquent and forceful orator. He has published ‹Historical and Political Addresses› (1898).

Redonda (rā-dŏn'dạ) **Island,** West Indies, one of the Leeward group, situated between Nevis and Montserrat. Iron and alumina mines constitute its economic importance. It is a dependency of Antigua, and with Barbuda, another dependency, makes an area of 62 square miles. The total population of the three islands is about 35,000.

Redowa, rĕd'ō-ạ, the name of a Bohemian dance introduced into England about 1846. The dance resembles the Polish mazurka. It was introduced into one of Meyerbeer's operas in 1849.

Red'path, James, journalist: b. Berwick-on-Tweed, England, 14 Aug. 1833; d. New York 10 Feb. 1891. He emigrated to Detroit, Mich., in 1848, and in 1852 removed to New York and became connected with the *Tribune.* In 1855 he went to Kansas and took part in the Free-Soil movement which he described for northern papers. Being already a confirmed anti-slavery advocate he traveled in the South for personal investigation of slavery conditions. With others he then undertook a scheme of colonization in Haiti and during his visits to the island was appointed by President Giffrard commissioner of emigration in the United States. The breaking out of the Civil War put an end to his plans, and he entered the field as war correspondent principally attached to the armies of Gens. Sherman and Thomas. At the close of the war, he became superintendent of education in Charleston, S. C., reorganized its school system, and established colored schools and the Colored Orphan Asylum. In 1868 he established the Lyceum Bureau in Boston which arranged for the public appearance of lecturers and readers, which business was afterward purchased by Maj. J. B. Pond (q.v.). Resuming editorial work on the *Tribune,* he went to Ireland to report the famine of 1879–80. There he became interested in the Home Rule movement and devoted several years to its interests. In 1886 he became attached to the staff of ‹The North American Review.› He assisted Jefferson Davis in preparing his history of the Southern Confederacy, and wrote, among other works, ‹The Roving Editor, or Talks with Slaves in the Southern States› (1859); ‹The Public Life of Captain John Brown› (1860); and ‹Talks About Ireland› (1881).

Redpoll, a small linnet-like finch of the far northern regions, two or three species of which visit northern Europe, Canada, and the northern United States in winter. The males have the head and neck beautifully rose-red in hue.

Redroot. See CEANOTHUS.

Reds of the Midi, The, a story by Felix Gras (q.v.), published in 1896. It is a strong tale of the French Revolution. One Pascal Le Patine, in his old age, night after night, in the shoemaker's shop, tells the story of his youth when he joined the «Reds of the Midi» (the insurgents of southern France), went to Paris, and witnessed all the horrors of the Revolution. The prologue of the tale is pure autobiography, and many of the characters are drawn from life.

Redshank, or **Gambet,** a large migratory snipe-like sandpiper (*Totanus calidris*) of Europe and Asia, representative of a large group, the American species of which are called willets by gunners; its average length is about 11 or 12 inches; and its popular name is derived from the red color of the legs. The spotted redshank (*T. fuscus*) and the greenshank (*T. glottis*) are allied species.

Redstart, in the United States a small active migratory warbler of the genus *Setophaga,* especially *S. ruticila* of the eastern part of the country, whose colors are a charming contrast of black and orange-red in the male, the female being more nearly brown and yellow. It has a sharp, exclamatory, but pleasing spring song, and makes a pretty nest of bark-shreds, etc., in an orchard tree or garden bush. The European redstarts are small brownish birds, closely related to the redbreasts, but distinguished by a bright red tail. They construct nests chiefly among the ivy of ruined buildings, the eggs numbering five or six, and being of a greenish-blue color. The redstarts are active birds, feeding on fruits, seeds, and insects, which they pursue on the wing. The song is low, but sweet, and these birds are said to imitate very skilfully the notes of other feathered songsters.

Redtail, a common American hen-hawk (q.v.).

Redtop. See GRASSES IN THE UNITED STATES.

Red'way, Jacques Wardlaw, American geographer: b. Nashville, Tenn., May 1849. He was educated at the University of California and at Munich, Bavaria. He occupied the chair of physical geography and chemistry at the State Normal School of California, was engaged in mining engineering and exploring in California and Arizona in 1870–80, and later pursued geographical investigations in South America, Europe, and Asia. He has published: 'Manual of Geography' (1887); 'Manual of Physiography' (1900); 'New Basis of Geography' (1901); 'Commercial Geography' (1902); etc.

Redwing, a European thrush (*Turdus iliacus*), visiting Great Britain and southern Europe in winter, when they flock in the fields in search of insects and worms. The summer song is pleasing, but the winter notes are harsh and unmusical.

Red'wood, Boverton, English chemist: b. London 26 April 1846. He was educated at the University College School and at the Pharmaceutical Society of Great Britain. As an authority on the technology of petroleum he accompanied Sir Vivian Majendie on his tour of inspection to the petroleum districts of Europe and America. He is adviser on petroleum to the Home Office and is consulted as an authority in that field by different branches of the British government. He is a member of the leading English and American scientific societies, was a member of jury at the Paris Exposition in 1900 and appointed a member of the Royal Commission to the Saint Louis Exposition in 1904. He has published: 'Cantor Lectures on Petroleum' (1886); 'A Treatise on Petroleum' (1896); 'The Petroleum Lamp' (with J. H. Thomson, 1902); etc.

Redwood, the name of various sorts of wood, as an Indian dyewood, the produce of *Pterocarpus santalinus;* the wood of *Gordonia Hæmatoxylon,* the redwood of Jamaica; that of *Pterocarpus dalbergioides,* or Andaman wood; that of *Ceanothus colubrinus,* the redwood of the Bahamas; that of *Soymida febrifuga,* of which the bark is used in India for fevers. In the United States, *Sequoia sempervirens* of the Pacific coast. See REDWOOD OF CALIFORNIA.

Redwood of California, the great cypress-like forest tree (*Sequoia sempervirens*) of the Pacific coast. It is of the same genus with the big trees (*S. gigantea*), botanically described under SEQUOIA; the latter occurs in scattered groups on the west slope of the Sierra Nevada, while the redwood forms dense forests on the west slopes of the Coast Range, where it forms the most important timber resource of the State. The forests were thoroughly studied by the government Bureau of Forestry in 1902, whose report furnishes the following facts: The redwood is popularly thought to occupy a strip of country 10 to 30 miles wide, from the Oregon line to the Bay of Monterey, but these boundaries do not cover its actual distribution. Two thousand acres of redwood exist in Oregon along the Chetco River. South of the Chetco a continuous redwood belt begins, and increases its width from 10 miles, at Del Norte County, to 18 or 20 miles, and keeps on unbroken to southern Humboldt County. Here is a break, but in Mendocino County the belt becomes dense again, and widens out to 35 miles. South of that county the tree grows in isolated patches as far south as the Santa Lucia Mountains.

The climate and topography that have brought about this limited distribution of the redwood deserve attention. North and south along the coast, in nearly parallel ridges, lie the mountains of the Coast Range, steep and rising to altitudes of 1,000 to 2,000 feet. A few large rivers and many smaller streams cut through them to enter the sea, and along their courses in places are broad bottom lands and gentle slopes. West of the Coast Range the climate is even and moderate, with a range from just below freezing to 80° F., and a yearly average of from 50° to 60°. Snow lies on the tops of only the highest ridges. Thirty to 60 inches of rain falls in the autumn and winter, and in the summer sea fog bathes the coast. But east of the mountains, less than 50 miles from the sea, lie hot interior valleys, never visited by the fog, parched and rainless in the summer, and wet only occasionally by the winter rains — conditions too unfavorable to permit the growth of the redwood. The forest may be considered in two types,— the «slope» and the «flat.» The common type is the «slope» — that is the growth on the steep sides of the Coast Range, which is a mixture of redwood, red fir, tanbark oak, and white fir, with an occasional madroña or hemlock. As the slopes become moderate, the altitude lower, the soil deeper, and the water supply better, the redwood steadily gains on the other kinds and the forest becomes denser, until on the rich flats and in the gulches the second type is developed; on the best redwood «flats» no other tree grows.

The redwood grows to a greater height than any other American tree, but in girth and in age it is exceeded by the big tree of the Sierras. On the slopes 225 feet is about the maximum height and 10 feet its greatest diameter, while on the flats, under better conditions, it grows to be 350 feet high, with a diameter of 20 feet, and occasional giants exceed this. Most of the redwoods cut are from 400 to 800 years old. After the tree has passed the age of 500 years it usually begins to die down from the top and to fall off in growth. The oldest tree scientifically examined began life 531 A.D. The tree, when normal, has a straight, slightly tapered bole, clear for more than 100 feet, and a crown of horizontal branches that may occupy from a third to a half of its total length. The roots strike downward at a sharp angle, and are so large and so numerous as to form a compact mass of wood, in shape like an inverted funnel. The bark of the tree offers such a remarkable resistance to fire that except under great heat it is not combustible. It is of a reddish-gray color, fibrous in texture, and gives to full-grown trees a fluted appearance. The tree, however, assumes many shapes.

The redwood requires little of the soil except that it be moist, and those trees in a gully or along a creek are larger than their neighbors on the ridges. It is, however, so dependent on moisture of the air that this factor mainly or wholly determines its distribution, and the eastern limits of the forest are determined by the distance inland to which the sea fogs may drift.

The enemies of the redwood are few, and it suffers from them less than other trees. «The wind,» remarks Fisher, «can scarcely uproot it, insects seem to do it little harm, and fungi seldom affect it. Even fire, the great enemy of all trees, though it may occasionally kill whole stands of young redwood growth, is unable to penetrate the fireproof sheathing of shaggy bark with which the old trees protect themselves.» A large area of redwood forest in Santa Cruz County has been reserved as a national forest-park.

Reproduction.— The redwood forest consists of a mixture of trees of widely varying type, and keeps itself stocked by reproduction under its own shade. Seeds grow up very seldom, the seed itself seeming to have little vitality and the opportunities for its germination being rarely present, because it demands plentiful light. Hence new growth is almost exclusively by suckers, which, supported and nourished by full-grown roots and stems, thrive under shade in which seedlings would wither. They thus survive and grow slowly, with little or no sun, until an old tree falls, lets in the light and they shoot up in rings about the stump into strong young trees. In 30 years, under favorable conditions, trees will result 16 inches in diameter and 80 feet high; and it is certain that it will be profitable to hold cut-over redwood lands for future crops. This second-growth timber has not the density and fine quality of the original, but is useful for many purposes, and large quantities have already been utilized.

Quality of the Wood.— Redwood is fitted for many uses. In color it shades from light cherry to dark mahogany; its grain is usually straight, fine, and even; its weight is light; its consistency firm, yet soft. It is easily worked, takes a beautiful polish, and is the most durable of the coniferous woods of California. It resists decay so well that trees which have lain 500 years in the forest have been sent to the mill and sawed into lumber. It has no resin, and resists fire, a fact which has recommended it as material for house-building, especially in San Francisco. Insects seldom injure it, because of an acid element its lumber contains. In sea water, however, the marine teredo eats off redwood piling as readily as other timber. Redwood is used for all kinds of finishing and construction for shingles, railroad ties, electric-light poles, paving blocks, tanks, and pipe staves. As a tie its average life, under heavy traffic, is six to eight years; as shingles it will last as long as 40 years. The chief difficulty in working redwood lies in the seasoning process, to dry it thoroughly being a slow and difficult process.

Lumbering.— The cutting of redwood for market began about 1850, and has steadily increased since with the market demand and growth of means of transportation. Its use is mainly confined to the State, and the greatest demand is from the southern counties. Occasional cargoes are sent across the Pacific, but it is rarely sent East, on account of the expense of transportation. It has never been a business giving extravagant profits. Several hundred thousand acres have already been cut over. A large part of this area has been completely cleared and cultivated or used for pasture but much remains as wild brush, believed to be useless; but it is now known that ordinarily a profitable second growth will arise, so that the anticipated extinction of the tree is no longer to be feared.

Felling one of these enormous trees is an operation requiring great experience and skill on the part of the woodsman, who must cause the vast trunk to fall precisely where he intends it to lie, and must take care that it is not split or broken by the concussion, to prevent which a bed is smoothed and prepared for it. A platform is then erected surrounding the trunk from six to eight feet above the ground. With a saw an undercut is made through the trunk, not quite to the centre, and from the opposite side a crosscut is sawed, ending a foot or two above the undercut and leaving a section of solid lumber between. When the exact place where the tree is to fall is selected, the choppers ascend the platform and with axes hew out an angular-shaped piece having the undercut as a base. When this cut is made the second or crosscut is wedged till the tree topples over and falls to the ground, the solid section of the trunk, not pierced by the cuts, supporting the tree till the centre of gravity is passed, and then the mighty frame falls on its prepared bed almost intact.

The next operation is performed by the «ringers» and «peelers.» Every 12 or 14 feet, as required, a ring is cut around the circumference of the bark, and afterward the peelers with crowbars and wedges «peel» the bark from the prostrate trunk. Finally all of the trees are stripped but surrounded with an immense accumulation of debris of bark and branches, which must be removed before the trunks can be sawed into suitable lengths for conveyance to the mill. The ground is cleared by fire, precaution being first taken to plug up the «splits» in the trunk with clay so that the fire may not reach the interior of the tree. A foggy day is chosen and a still one. Fire is started and in a short time the tract is burning with a fierce heat that quickly reduces the piles of bark and brush to ashes, and leaves an unobstructed field for the removal of the timber which has been scarcely charred by the intense heat to which it has been subjected.

The trunks as they lie are then sawed into stated lengths, and then follows the arduous task of conveying these enormously heavy sections to the railroad. Temporary skidways are laid down and roads constructed. Chutes down which the logs pass have to be planned, and on these, guided by the skilful woodsmen, the unwieldy logs at last reach their destination. The work is assisted by donkey engines on sleds, which are hauled to the top of the steep banks and into seemingly impossible situations.

In 1903, the yield of virgin redwoods on the northern flats was from 125,000 to 150,000 board feet per acre. About Humboldt Bay it was from 50,000 to 75,000 feet per acre; and on slopes like those in Sonoma County, from 20,000 to 30,000 feet. The amount of timber got out of a redwood forest is only a small proportion of what the stand contained. At least a quarter of the timber is destroyed in felling and in the burning that follows, and of what remains all the broken and misshapen logs are left on the ground.

Bibliography.— Consult: Fisher, 'Report on Redwood,' Bureau of Forestry (Washington, 1903); and authorities on California, especially Muir, and on forestry. See FORESTRY.

Reed, rēd, **Andrew**, English philanthropits: b. London 27 Nov. 1787; d. there 25 Feb. 1862. He was educated at Hackney College, London, ordained pastor of the Congregational Chapel at New Road, London, in 1811 and remained in this charge until 1861. He visited the United States in 1834 to study educational and religious systems and established in London the Orphan Asylum (1813), Infant Orphan Asylum (1827), Asylum for Idiots (1846), Royal Hospital for Incurables (1855), and an Asylum for Fatherless Children in Croydon. He published 'Visits to the American Churches' (1836); 'Advancement of Religion the Claim of the Times' (1847); etc. Consult 'Memoirs,' edited by his sons (1863).

Reed, Sir Charles, English politician and philanthropist, son of Andrew Reed (q.v.): b. near Sonning, Berkshire, 20 June 1819; d. Tottenham, Middlesex, 25 March 1881. He amassed a large fortune in the typefounding business, took an active interest in the philanthropic works of his father, served in Parliament as member for Hackney in 1868–74, and was reelected for Saint Ives in 1880. He was president chairman of the London School Board in 1873–81 and in 1874 he was knighted.

Reed, Charles Alfred Lee, American surgeon: b. Wolf Lake, Ind., 9 July 1856. He was educated at Miami University, Oxford, Ohio, and studied medicine at the Cincinnati College of Medicine and Surgery. He was professor of gynæcology and abdominal surgery at the Cincinnati College of Medicine and Surgery 1882–95; became gynæcologist at the Cincinnati Hospital in 1896; and was president of the American Medical Association in 1900–1. He has published various professional monographs and a 'Text Book of Gynæcology' (1900).

Reed, Sir Edward James, English naval architect: b. Sheerness 20 Sept. 1830; d. 30 Nov. 1906. He was educated at the School of Mathematics and Naval Construction in Portsmouth, was at one time connected with Sheerness dockyard, and having become an authority on naval architecture, was appointed chief constructor to the navy, for which he designed a number of ironclads and other vessels. He resigned in 1870 on account of his objections to rigged sea-going turret ships which he found to be growing in favor. He sat in Parliament for the Pembroke boroughs 1874–80, for Cardiff in 1880–95, and again 1900–06. In 1886 he was a junior lord of the treasury under Mr. Gladstone. In 1878 he visited Japan on the invitation of the government of that country. He published: 'Japan, its History, Traditions, and Religions' (1880); 'The Stability of Ships' (1884); 'Modern Ships of War,' with Admiral Simpson (1888); 'Poems' (1902).

Reed, Elizabeth Armstrong, American author: b. Winthrop, Maine, 16 May 1842. She was married to H. V. Reed in 1860. She was chairman of the Woman's Congress of Philology in Chicago in 1893, and has been a member of several learned societies. She has published: 'The Bible Triumphant' (1866); 'Hindu Literature: or the Ancient Books of India' (1891); 'Persian Literature, Ancient and Modern' (1893); Primitive Buddhism, its Origin and Teachings' (1896); etc.

Reed, George Edward, American educator: b. Brownville, Maine, 21 March 1846. He was graduated from Wesleyan University, Middletown, Conn., in 1869 and after studying theology in Boston University, entered the New England Southern Conference in 1870. He filled important appointments in the Methodist denomination 1870–89 and in the year last named became president of Dickinson College, Carlisle, Pa.

Reed, Hugh T., American military officer: b. Richmond, Ind., 17 Aug. 1850. He was graduated from West Point in 1873 and served chiefly on frontier duty until 1881 when he was appointed inspector-general on the staff of Governor Porter of Indiana. He was retired for disability in 1889. He has published: 'A Calendar of the Dakota Nation' (1887); 'Cadet Regulations' (1881); 'Broom Tactics' (1883); etc.

Reed, Joseph, American soldier and statesman: b. Trenton, N. J., 27 Aug. 1741; d. Philadelphia 5 March 1785. He was graduated from Princeton and spent two years studying law in the Middle Temple, London. He returned to Trenton and took up the practice of law, and in 1767 was appointed deputy secretary of New Jersey. In 1774 he was appointed a member of the committee of correspondence for Philadelphia and in 1775 was president of the 2d provincial convention held in Pennsylvania, and endeavored to defeat the intention of arming the province. His English connections through his marriage inclined him to a conciliatory view of the English position, though he opposed the principle of parliamentary taxation. On Washington's appointment to commander-in-chief, Reed became his military secretary. In 1776 he was made adjutant-general, but resigned the next year and refused the office of brigadier-general and also first chief justice of Pennsylvania, preferring to remain Washington's volunteer aide, without rank or pay. In September 1777 he was elected to the Continental Congress, but continued with the army and took part in many engagements. In 1778 he was made chairman of a Congressional committee to confer with Washington concerning the management of the ensuing campaign. In December 1778 he was chosen president of the Supreme Executive Council of Pennsylvania and continued in office for three years, during which time he was one of the founders of the University of Pennsylvania, and favored the doing away with the proprietary powers of the Penn family. After the English peace commissioners had failed to treat with Congress, attempts were made to bribe Reed together with other high officials. He replied: «I am not worth purchasing, but such as I am, the king of Great Britain is not rich enough to do it.» In 1780 he was invested with extraordinary powers and was principally successful in quelling the dissatisfaction of the Pennsylvania troops in the army. Consult 'Life' by Henry Reed (1846); W. B. Reed, 'Life and Correspondence' (1847).

Reed, Myrtle, American author: b. Chicago, Ill., 27 Sept. 1874. She has published 'Love Letters of a Musician' (1899) which has been widely read; 'Later Love Letters of a Musician' (1900); 'The Spinster Book' (1901); 'Lavender and Old Lace' (1902).

Reed, Thomas Brackett, American statesman: b. Portland, Maine, 18 Oct. 1839; d. Washington, D. C., 7 Dec. 1902. He was graduated from Bowdoin College in 1860, winning the first prize in English composition. He then took up the study of law, went to California in 1863, and was admitted to the bar there. In 1864 he was appointed assistant paymaster in the United States Navy, and assigned to a gunboat patrolling the Tennessee, Cumberland and Mississippi rivers. On receiving his discharge from the navy, he returned to Portland and established a law practice. His interest in public affairs and ability as a speaker soon made him prominent in the Republican party in Maine, and in 1868 he was elected to the lower house of the State legislature, where he served two years. He then entered the State Senate, and before his term had expired, was elected attorney-general of Maine. From 1874 to 1877 he was city solicitor of Portland, and in 1876 was elected to Congress and served there continuously until his resignation in 1899. He first attracted attention in April, 1878 by a speech in opposition to a bill to reimburse William and Mary College for losses sustained at the hands of the Federal troops during the War. From that time his readiness in debate, knowledge of parliamentary law, and marked executive ability made him a power in the House. In 1885–9, while the Republicans were in the minority, he was their acknowledged leader on the floor, and in 1889 was chosen Speaker of the House. The Republican majority was small, and the business of the House continually delayed by the «filibustering» course of the Democrats. Speaker Reed did not hesitate to enforce strict rulings against such tactics, and ordered the clerk to count as present all members actually in the House, whether they answered to the roll-call or not. This aroused the strongest opposition from the Democrats; his conduct was denounced as tyrannous and illegal, and the epithet of «Czar» applied to him. His rulings were, however, sustained by the House, and later by the decision of the Supreme Court; and in the next Congress, when the Democrats were again in power, he had the satisfaction of seeing his rules adopted by the party that had so violently denounced them. In 1895 and 1897, he was again elected speaker, and this time his conduct of the business of the House met with the approval of both parties. As Speaker, he had a powerful influence in constructing and guiding legislation, though his name is connected with no single important measure, and he raised that office to a position second only to that of the President of the United States. He was a consistent opponent of free silver, and was largely instrumental in defeating the free silver bill of 1890. He was also a strong advocate of the policy of protective tariff, but was opposed to the administration policy in regard to imperialism and the questions resulting from the Spanish War. To this fact his resignation from Congress in 1899 is sometimes attributed. In 1896 he was a prominent candidate for the presidency, and at the Republican National Convention received 84½ votes, being second to McKinley. After 1899 he was engaged in the practice of law in New York. He contributed frequently to the magazines, edited a series of volumes on oratory entitled 'Modern Eloquence,' and published 'Reed's Rules of Parliamentary Procedure.'

Reed, Walter, American military surgeon and bacteriologist: b. Harrisonburg, Rockingham County, Va., 1851; d. Washington, D. C., 23 Nov. 1902. He was graduated from the medical department of the University of Virginia and from the Bellevue Hospital Medical College of New York, and was made 1st lieutenant assistant-surgeon, U. S. A., 26 June 1875. His promotions were captain assistant-surgeon 26 June 1880, and major surgeon 4 Dec. 1903. In 1890–1, while stationed at Baltimore, he made particular study of bacteriology in the laboratory of Professor William Welch, of the Johns Hopkins University; and established a laboratory of his own, in which he gave instruction to the student-officers of the Army Medical School. As curator of the Army Medical Museum, at Washington, D. C. (from 1893), he continued his researches, and soon became

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known as one of the leading bacteriologists of the country. His ability was especially displayed in his investigations of the cause and progress of epidemic diseases. In 1898 he was made head of a board for the study of the epidemics of typhoid occurring among the troops collected for the Spanish-American war. After the war he made several voyages to Cuba, and was on duty at Havana, studying the diseases of the island, and more particularly yellow fever, as a member of a board for its investigation. After a series of brilliant experiments, he was able to announce that yellow fever is conveyed by a certain variety of mosquito (*Stegomyia fasciata*), individuals of which become infected by biting persons ill with the fever and by their bite introduce it into the blood of non-immunes. The United States military government at once proceeded to measures of extermination which banished the fever from Havana, where it had prevailed for three centuries. The Atlantic seaboard of the United States was also thereby freed from constant peril. This achievement must rank among the important triumphs of bacteriological science. Consult Keane, 'Scientific Work and Discoveries of the Late Major Walter Reed' (Senate Doc. 118).

Reed, William Bradford, American lawyer: b. Philadelphia 30 June 1806; d. New York 18 Feb. 1876. He was graduated from the University of Pennsylvania in 1825 and accompanied Joel R. Poinsett to Mexico as private secretary. Then taking up the practice of law, he became attorney-general of Pennsylvania in 1838. In 1850 he was appointed professor of American history at the University of Pennsylvania, and in 1857 became United States minister to China. The next year he negotiated the treaty with China which regulated commercial relations as well as made more secure the rights obtained by the previous treaty of 1844. Subsequent to his return to America in 1860 he settled in New York and corresponded for the London *Times* besides contributing to 'The American Quarterly Review' and the 'North American Review.' He engaged in a controversy with George Bancroft, concerning certain statements repeated by the historian to the effect that his grandfather, Joseph Reed, meditated abandoning the American cause and going over to the British In this controversy Reed wrote 'President Reed of Pennsylvania, a reply to George Bancroft and Others' (1867). Bancroft responded with 'Joseph Reed, an historical Essay' (1867), to which Reed replied with 'A Rejoinder to Mr. Bancroft's Historical Essay' (1867). He published 'Life and Correspondence of Joseph Reed' (1847); 'Life of Esther de Berdt' (1853).

Reed, (1) in music, the sounding part of several instruments, such as the clarinet, bassoon, oboe, and bagpipe, so called from its being made from the outer layer of a reed (*Arundo sativa* or *donax*) found in the south of Europe. The name is also applied to the speaking part of the organ, though made of metal. Reeds are generally divided into two kinds — the beating reed, used in the organ, clarinet, etc., requiring to be placed upon a tube to produce a musical sound, and the free reed, used in instruments of the harmonium and concertina kind. (2) In weaving, an appurtenance of the loom, consisting of two parallel bars set a few inches apart, and furnished with a number of parallel slips or reeds, called dents, between which the warp threads are passed. The reed is set in a swinging frame, called a lathe, lay, or batten. In the hand lathe, the bottom of the batten is furnished with a shelf, called the shuttle race, along which the shuttle is driven. The office of the reed is to beat the weft up to the web, and the force of the blow determines the compactness of the fabric.

Reed, Flue, and Stringed Instruments, Temperament, Tuning, and Voicing of. *Temperament.*— The intervals of the perfect octave are divided naturally into 53 parts or commas, the successive sounds of the diatonic scale being separated by these commas into the following intervals:

C	to D	9 commas	9
D	" E	8 "	17
E	" F	5 "	22
F	" G	9 "	31
G	" A	8 "	39
A	" B	9 "	48
B	" C	5 "	53

Nature's arbitrary division of the octave, into intervals of exact dimension, is not satisfactory, nor does it admit of an exact equalizing; the only possible approach to it being by the method known as the «even temperament,» which method or principle was discovered and established by John Sebastian Bach, in the early part of the 18th century, who learned that certain intervals would bear being tuned sharp (in excess of) or flat (short of) perfect; the thirds and fourths being tuned sharp and the fifth tuned flat of perfect, thus distributing among all the 12 keys of the octave, the three commas or points by which the major tones exceeded the minor, thus rendering equal the five tones in the diatonic series. Previous to this time, it had been the custom to tune to perfect intervals, those keys having not over 3 sharps or flats and play in those keys only. The problem to be solved was to so divide the octave into 12 semitones by fixed sounds, that each one of the 12 sounds could be made the key note upon which a properly proportioned diatonic scale could be based, either in the major or minor form and a melodic or harmonic progression made possible through the whole 24 major and minor scales; so that from any one of these 12 notes, a uniform chromatic scale could be constructed, thus making possible, modulations of unlimited variety and beauty.

The method then of tempering the notes of keyed instruments, consists in arbitrarily adjusting the enharmonic diesis, that is, the distinction there is naturally between D sharp and E flat, G sharp and A flat, by tuning these notes too sharp for one and too flat for the other of these natural tones or intervals, and by making a similar compromise between the more minute discrepancies of the diatonic scale. Thus while no interval will be exactly true, yet none will be so adjusted as to shock the ear by false intonation, but rather add a color or quality to the tonality of the instrument, which, though harmonious, would otherwise be characterless.

Rule for Tempering Pianos and Organs.— Tune middle C to desired pitch, then tune F — fifth below — sharp of C, until between C and F, there result three beats in five seconds. Next tune A-sharp — fourth above F-sharp of the latter, until there results one beat, each second. Next tune G — fourth below middle C — flat of C, by one beat a second; then tune D — fifth above — flat to G, by three beats in five seconds; A — fourth below — flat to D; E — fifth above — flat to A; B — fourth below — flat to E; F-sharp — fourth below — flat to B; C-sharp — fifth above — flat to F-sharp; G-sharp — fourth below — flat to C-sharp; D-sharp — fifth above — flat to G-sharp, which will make D-sharp as sharp of A-sharp, as the latter is sharp of the first F tuned.

In all the above intervals, the fifths beat three times in five seconds; the fourths beat once a second, or five times in five seconds. All the 12 notes, from F below middle C to first E above, have now been tuned; the temperament has been confined to the smallest possible compass to lessen the liability of errors, and if the first F above middle C is now tuned three beats in five seconds, flat of A-sharp below, it will be a perfect octave to the first F tuned.

Tuning.— The art, principle or act of so adjusting the intonations of keyed musical instruments as to make possible consecutive musical tones agreeable to the ear. The method varies according to the kind or character of the instrument. Where strings are used, as in pianofortes, harps, violins, violas, guitars, zithers, etc., tuning consists in adjusting the tension of the strings by turning the pins or pegs around which the strings are wound. In band and orchestral wind instruments, a crook or joint is used, sometimes called a slide, because it slides in and out to adjust the length of the column of air in the tube to the point where the desired pitch of the fundamental note is obtained.

In reed organs it depends upon the adjustment of the comparative weight, length and thickness of the reeds, and in pipe organs upon the length of the vibrating column of air in the flue pipes.

In the tuning of strings, the pitch is determined by the size, length and tension of the wire. In reed tuning the desired pitch is obtained by filing or scraping the reed; at the base or fixed end to flatten the tone and at the point or free end to sharpen it.

Organ pipes are tuned according to their construction. The large open flue wood pipes are lowered or flattened in pitch by being lengthened by a sliding cap or by a board fastened to the back, at the top, and is raised or sharpened in pitch by being shortened.

The large open metal flue pipes are tuned by cutting away or adding to the length, or by a slit in the back near the top, making two flaps to be opened or closed as required; closing them lowers the pitch, opening them raises it; the smaller metal pipes being tuned by the use of a conical horn, with which the tops of the pipes are contracted or expanded, as the pitch is to be lowered or raised respectively. Stopped metal pipes are tuned by a cap, raised or lowered as desired, and reed pipes by adjusting the wire which bears upon the reed, the raising or drawing up of the wire increasing the effective length of the reed and so flattening it and *vice versa.* In the tuning of pipe organs, the reed pipes are the last to be tuned, since they are the most liable of all the pipes to become disarranged.

Voicing of Keyed Musical Instruments.— The voicing of organ pipes consists in the adjustment of their various parts, consisting of the mouth, throat, lips, languid and ears, the correct method of treatment having been learned by experience, many years ago and of late years demonstrated by mathematical calculations, and by the investigations of scientists.

The languid is that flat piece of the pipe which lies horizontally above the upper part of the foot, and it is against this languid, the «sheet of wind» is forced from the «wind way» below. Some of the pipes have the languids grooved upon their face, as one method of voicing, and some metal pipes are voiced by bending the ears, which are placed on either side of the mouth. Pipes once voiced at the factory seldom need any alteration.

The voicing of reeds in the common house organ is accomplished by giving the free end of the reed, a slight curl or circumflex, and this also causes the reed to speak or sound more promptly and with less pressure of wind.

The voicing of pianos consists in the stabbing of the felt of which the hammers are made, by several needles fastened in a handle. The thrusts should be made directly toward the centre of the hammer and not through the top of the felt, from the sides. In the making of hammers, which is done by machinery, one entire set being covered with felt at a time, there is a variation as to hardness in the individual hammers, and voicing is relied upon to lighten up the felt, and give a uniform character of tone throughout the entire scale of the piano.

Edward Quincy Norton,
Author of 'Construction, Tuning and Care of the Pianoforte.'

Reed-bird. See Bobolink.

Reed Canary Grass, a grass of the genus *Phalaris.* See Grasses in the United States.

Reedbuck. See Reitboks.

Reeder, Andrew Horatio, American politician, first governor of Kansas Territory: b. Easton, Pa., 6 Aug. 1807; d. there 5 July 1864. He practised law at Easton and was prominent Democratic politician when, in 1854, he was appointed by President Pierce the first governor of the newly formed territory of Kansas. Upon arriving at his post he at once rendered his position difficult by declaring his intention rigidly to put down the violence resulting from the conflict of the two parties respecting slavery. In the election of March 1855 more than three fourths of the votes cast were illegal, but the governor issued certificates of election to all claimants whose papers were regular and against whom no protests or official notice of frauds were presented. His action he defended as strictly legal and declared that any other would have been revolutionary, though he confessed to knowledge of the fraudulent voting. He was dismissed from office by the President and he returned to Lawrence to reside and to join forces with the Free-Soil movement. He was nominated by this party as territorial delegate to Congress. A legislature of the Free-State party formed under the instrument known as the Topeka Constitution elected him to the United States Senate in 1856.

But the election was refused ratification by Congress. President Lincoln appointed him a brigadier-general at the outbreak of the War, but considerations of age induced him to decline. Consult: Spring, 'Kansas' (1885); Robinson, 'The Kansas Conflict' (1892).

Reedfish, a crossopterygian ganoid fish (*Calamoichthys calibaricus*), which, with the bichir (q.v.) is the only survivor of a group prominent in Palæozoic time, which dwells in the sluggish reedy rivers of the Senegal coast of Africa, searching the mud of the bottom for prey.

Reef, the part of a sail comprehended between the top or bottom and a row of eyelet holes generally parallel thereto. The object of the reef is to reduce the surface of the sail in proportion to the increase of the wind; for which reason there are several reefs parallel to each other in the superior sails; thus the top-sails of ships are generally furnished with three reefs, and sometimes four; and there are always three or four reefs parallel to the foot or bottom of those main-sails and fore-sails which are extended upon booms. When a reef has to be taken in the sail is slightly lowered; the men climb out along the lower boom or yard, which they lean over, with their feet supported by the foot-ropes, fold the loose portion of the sail around the yard, and tie them up with the cords inserted in the eyelet-holes. As the operation of reefing is dangerous in stormy weather many ships are now fitted up with a patent apparatus by which sails may be reefed from the deck.

Reef also implies a chain of rocks lying near the surface of the water.

Reel, a revolving contrivance on which fibre, thread, cord, rope, fabric, etc., are wound, to form them into hanks or skeins, and for various other purposes; applied to:

In agriculture, a device having radial arms carrying horizontal slats, and rotated by gear or pulley connected with the axle of a harvester, for pressing backward and holding the stalks of grain in position for being severed by the knives. In angling, a skeleton barrel attached to the butt of a fishing rod, around which the inner end of the line is wound, and from which it is paid out as the fish runs off with the bait, and is gradually wound in again as his struggles become less violent, bringing him to land or to the landing net. In baking, a cylinder with radial arms rotating in a heated chamber, carrying pans in which loaves of bread are placed for baking in the reel-oven. In cotton machinery, a machine on which cotton is wound, making hanks of thread. In domestic industry, a spool or bobbin of wood on which cotton, thread, silk, etc., is wound for use in sewing.

Also the name of a lively rustic dance in which the couples sometimes swing or whirl round, and sometimes pass, forming the figure 8. In the United States, the Virginia reel is widely popular. Also the music for such a dance, generally written in common time, but sometimes in jig time of six quavers to a bar. The Scotch dance known as a reel is executed by two couples, the music for which is generally written in common time of four crotchets in a bar, but sometimes in jig time of six quavers.

Reem, in Scriptural zoology, *Bos primigenius*. In the Authorized Version the influence of the Septuagint has prevailed, and the word is translated "unicorn," but erroneously, as the mention of two horns on one reem (Deut. xxxiii. 17) proves. The word unicorn has disappeared from the Revised Version, wild ox being substituted for it; but in Num. xxiii. 22, the alternative rendering ox-antelope (*Oryx leucoryx*) is given in the margin. The term is still a vernacular name among the Arabs of the Sahara for a gazelle (*Gazella loderi*).

Rees, rēs, **Abraham**, English Presbyterian clergyman: b. Llanbrynmair, Wales, 1743; d. 9 June 1825. He prepared for the ministry at Hoxton Academy, where in his 19th year he was appointed mathematical tutor to the institution, and soon after resident tutor, in which capacity he continued upward of 22 years. He was pastor to the Presbyterian congregation of St. Thomas', Southwark, 1768–83, and of a congregation in the Old Jewry from 1783 till his death. In 1776 he undertook a revision and expansion of 'Chambers' Cyclopædia,' which he completed in 1785. The success of this work led him to a new undertaking, similar in its nature, 'The New Cyclopædia,' in 45 volumes (1802–20), republished at Philadelphia in 47 volumes.

Rees, John Krom, American educator: b. New York 27 Oct. 1851; d. there 9 March 1907. He was graduated from Columbia in 1872, and from the Columbia School of Mines in 1875. He filled the position of assistant professor of mathematics in the Columbia School of Mines 1873–6, and was professor of astronomy in Washington University, Saint Louis, 1876–81. He was director of the observatory and instructor in geodesy and practical astronomy in Columbia 1881–4 and from 1884 professor of astronomy there. He was president of the New York Academy of Sciences in 1894–6, was elected fellow of the Royal Astronomical Society of London; and in 1901 received the decoration of Chevalier of the Legion of Honor.

Reese, rēs, **Michael**, Californian pioneer: b. Heinsforth, Bavaria, 1816; d. Germany 2 Aug. 1878. Apprenticed to a tanner he worked at his trade until he emigrated to the United States, and there after some reverses he established a jewelry business in which he was successful. In 1850 he went to California and began investing in San Francisco real estate. When the Fraser River excitement was at its height, Berri, a Swiss banker, disheartened as to the future of San Francisco, expressed to Reese his desire to part with his holdings. Reese having a firm belief in the coming importance of the city purchased Berri's property and thus laid the foundation of his great wealth. Among his benefactions was his gift to the University of California of the Lieber Library. The Michael Reese Hospital of Chicago, Ill., is his memorial, while his legacies to charities in the aggregate reached half a million dollars.

Reeve, rēv, **Tapping**, American jurist: b. Brook Haven, L. I., October 1744; d. Litchfield, Conn., 13 Dec. 1823. He was graduated from Princeton in 1763 and in 1767–70 was engaged as a tutor there. In 1772 he established a law practice at Litchfield, and during the war served as a recruiting officer and as a member of various committees of safety and defense. In 1784 he opened a law school at Litchfield which became justly famous and for years was without an American rival. He conducted it without assistance until 1795, when he became associated with James Gould, who succeeded him in 1820. He was a judge of the supreme court of Connecticut in 1798–1814, served as chief justice for a short time, and subsequently served a single term in each the legislature and the council, after which he declined to hold further office. He was a Federalist, a lawyer of high ability, and was the originator of the movement to secure to married women the legal right to dispose of their own property. He published: ‘The Law of Baron and Femme; of Parent and Child; of Guardian and Ward; of Master and Servant,’ etc. (1816), republished in numerous editions; and ‘A Treatise on the Law of Descent’ (1825).

Reeve, a bird. See RUFF.

Reeves, rēvz, **Helen Mathers,** English novelist: b. Misterton, Somerset, 26 Aug. 1853. In 1876 she was married to Henry Albert Reeves, a London surgeon. ‘Comin’ Through the Rye,’ her first story (1875), was widely popular both in this country and her own, and among her later fictions are ‘Cherry Ripe’ (1877); ‘As He Comes Up the Stair’ (1878); ‘My Lady Green Sleeves’ (1879); ‘The Sin of Hagar’ (1896); ‘Becky’ (1900). Her style is pleasing and animated and the interest of her novels is well sustained.

Reeves, John Sims, English tenor singer: b. Woolwich, Kent, 26 Sept. 1818; d. Worthing, Sussex, 25 Oct. 1900. He studied music and, in 1832, became organist in the church of North Cray, Kent, and made his first appearance as a singer in 1839 on the Newcastle stage. He first sang in London in 1842, and having studied in Paris and Milan made his first appearance at the La Scala theatre of the latter city as Egardo in Donizetti's opera ‘Lucia di Lammermoor.’ His voice was of wide compass and great beauty — mellow and powerful, capable of the tenderest pathos and of the most stirring martial appeal, but always controlled by genuine artistic feeling and knowledge. He was heard to most advantage in the concert hall and in oratoria parts, and in such pieces as ‘Guy Mannering’ he displayed considerable histrionic ability. He published ‘Life and Recollections’ (1888); and ‘My Jubilee’ (1889).

Referendum, which, together with *Initiative* (see below), constitute what is known as Direct Legislation, is a method by which citizens can at all times control their own lawmaking. The Referendum is «the referring of legislation to the people for final rejection or acceptance;» the Initiative is «the giving to the people the right of proposing legislation to be acted upon.» Another provision of the Referendum is that, ordinarily, no law shall go into effect without waiting a certain period, say ninety days. If, during that period, a portion of the voters, say ten per cent, sign a petition for a Referendum on that particular matter, it shall not become law until voted on at the next election, when an adverse vote would veto it.

Different Kinds of Referendum.— There are, in principle, several kinds of the Referendum; the Optional, Obligatory, Executive, Legislative and Judicial. The first is meant where the general term, Referendum, is used alone. The Obligatory Referendum, which means that every law has to be referred to the people, is used on constitutional amendments in every State except Delaware. The other three are sufficiently described by the adjectives prescribing whether the reference to the people shall be by executive action, by that of a minority or the legislature, or by that of the supreme court.

What Direct Legislation is not.— It does not do away with legislatures; it does not necessarily mean that all laws or even many laws shall be submitted to the people — indeed, in practice, very few laws are so submitted; it is not an instrument of impulse or sudden passion, for much time must elapse for reflection and discussion before the process is consummated; nor does it detract from the dignity or honor of the legislature.

Advantages of Direct Legislation.— De Tocqueville says that «the only way to interest people in their government is to make them partake in it.» Direct legislation tends to interest every voter, because it makes him a potential legislator; it thus has great educational and practical value. The laws are more likely to be made short, simple and direct if they are to be understood by the people; and, if the laws have an actual popular backing, they are far more likely to be enforced.

History of the Referendum.— The seeds of this democratic principle are to be found in the ancient Ecclesia of Athens, the general assembly of Solon in the sixth century, B. C., the Roman Comitia Tribula, or meeting by tribes, the gathering of the German *ceorls* (churls), the *landsgemeinden* or assemblies of the Swiss people from time immemorial, and, on this side of the water, the New England town meeting. But to the Swiss is given the credit for the direct origin of the modern Referendum, for Switzerland is considered its home and its exemplar, where it has been more highly developed than elsewhere and so successfully applied, for several centuries, that, as one writer views it «only an act of extreme violence could wrest it from the statute books.» From Switzerland it is invading France, Norway, England (to a slight extent as yet), Australia, New Zealand, Canada and, more promisingly than elsewhere, the United States.

The Referendum in the United States.— Inspired by the success of Direct Legislation in Europe, a number of political reformers in New Jersey organized the first Referendum League in 1892, and since then the reform has been making non-partisan progress, at first slowly but lately with accelerated speed. In 1898 South Dakota was the first State to incorporate Direct Legislation in her constitution, although the year before Iowa and Nebraska had enacted modified forms of the Referendum. South Dakota was followed in 1900 by Utah, in 1902 by Oregon, and in 1904 by Nevada. In 1906 Montana adopted it; in 1908, Missouri and Maine; in 1910, Arkansas and Colorado; in 1911, Arizona, California and New Mexico. Several other western States have also agreed to submit the question of the Referendum to popular vote. The application of the Referendum to municipal affairs has become widespread not only among Pacific coast cities but in Denver, Col., Minneapolis, Minn., Detroit, Mich., Nashville, Tenn., and others. And every year the cities of Massachusetts, Vermont and New Hampshire vote on the license question.

The Initiative.—As the Referendum, giving the people the veto power over bad laws represents the negative side, the Initiative is a positive factor and enables the people to originate laws. If a certain percentage of the voters, the number ranging from 8 per cent. in Oregon to 15 per cent. in Los Angeles, Cal., file a petition for a law or, in the case of a city, an ordinance, it must be sent to the legislature or, in certain circumstances, directly to the people. The Initiative thus gives the people the power to start good laws on the way to the statute books and, by their own vote, to see that they are enacted.

The Recall.— Usually associated with Direct Legislative, and yet not a constituent part of it is the Recall, or, as it is sometimes called, the Imperative Mandate. It is a process by which, if any of the constituents of a public officer disapprove of his actions they can, by signing and filing a petition for his recall suspend him from office. The percentage required for petitions ranges from 20 and 25 per cent. to 60 per cent. The Recall thus gives to citizens the right of the private employer — to discharge unsatisfactory employes. If the person recalled is an elective officer, a new election is held for the balance of his term, and the old officer is a candidate for re-election if he desires, while other candidates are nominated in the regular way.

In Switzerland nearly a third of the States have the Recall; and in the United States: Oregon, Washington, South Dakota, Arizona, California, and many cities possess the right, which, however, has been sparingly exercised; it is too serious an instrument for frequent or ordinary use. At Los Angeles it has been used twice — in 1904, to recall a councilman; and, in 1909, to remove the mayor. It was in Los Angeles also where its use as a deterrent was exemplified, the council being compelled under threat of recall to restore to the city three miles of riverbed worth $1,000,000; and, in 1909, the threat of recall forced the Oregon legislators to give pledges that they would abide by the popular vote for senators. In 1909 two Oregon cities recalled their mayors and, in one instance, all other officials, in 1911 two Washington cities recalled their mayors.

The Recall of Judges.— The Recall, as applied to judges, is a different and far more serious phase of the principle, and a point at which public opinion at present calls a halt. It was this feature in her constitution which so long held Arizona back from the attainment of statehood; and it was not until the people of Arizona, by a practically unanimous vote eliminated the objectionable feature that President Taft signed the bill for the State's admission.

Direct Primary, or Direct Nominations.— This is a system of nomination to public office which does away with the nominating convention. It is in effect "the selection by the party members of the men of their choice for nomination, in the same way that the general electorate on election day, select the men of their choice for public office." It makes the representative responsible to the voters only and not to any leaders or bosses; it provides for sound party organization and for real party leadership; and it brings out the voters.

Three-fifths of the States employ the Direct Primary System for practically all party nominations. These States contain considerably over one-half the population of the United States. If we add others in which the system is used in some form, the proportion of States enjoying Direct Primaries, in whole or in part, in 1912, is 81 per cent.

Refining of Metals, in metallurgy, the last step in the purifying of gold, silver, tin, copper, lead, etc. See METALLURGY, ASSAYING, GOLD, SILVER, etc.

Reflecting Galvanometer, the most sensitive galvanometer yet invented, devised by Sir William Thomson for use in connection with the Atlantic submarine cables. A short needle is rigidly attached to a small concave mirror and suspended by a silk fibre in the centre of a vertical coil of small diameter. This mirror is adjusted by means of a directing magnet to throw the rays of light (falling on the mirror through a hole having a fine wire stretched upright across it and placed just under the graduated scale opposite the mirror) back on the scale. An image of the wire is thus thrown on the scale, and the slightest motion of the needle and its mirror will produce a much greater motion of this image.

Reflection. See LIGHT.

Reflector, the name of a device by which the rays proceeding from a luminous or heated object are thrown back or diverted in a given direction. The reflecting surface may be either plane or curved. In practice it is often made spherical or parabolic. The former does not bring the rays to a true focus, but is easily formed, and is consequently generally employed where extreme accuracy is not sought for. A mirror is a familiar example of a plane reflector.

Reflex Action, a non-voluntary reaction affecting a muscular apparatus in response to some kind of sensory stimulus. Such a reaction implies the traversing of the sensory stimulus to some nerve centre or centres in the brain, the medulla, or the spinal cord, and the setting free of a muscular response, general or local, to certain organs of the body, without the participation of willed conscious action, although conciousness of a reflex act performed may precede or accompany the act. Many of these reflexes are extremely intricate, so intricate in fact that certain philosophers have attempted to show that all life-processes are of the type of reflex actions. Many reflex actions, by reason of the fact that their muscular equivalent acts on blood-vessels, may increase or decrease glandular activity. Thus fright may destroy the ability of the stomach to digest. Dryness of the mouth is frequent as a result of certain forms of unconscious excitement, and many if not all of the emotions may be regarded essentially as intricate forms of vasomotor reflexes. Further reflexes are constantly operative and affect the normal metabolism of the skin or the bones, and still others are concerned in the general nervous equilibrium of the entire body — the so-called neuromuscular tone. See CONSCIOUSNESS; EMOTION; MUSCLE-SENSE; NERVOUS SYSTEM; TELEPATHY.

Reform Acts, a term applied to certain acts of the British Parliament by which the regulations as to the parliamentary representation of the people were altered, and especially to those of 1832, 1867, and 1884–5. In the third successful effort for parliamentary reform, that of 1884–5, the franchise and redistribution of seats constituted two distinct acts. The franchise bill received the royal assent on 6 Dec. 1884, and came into operation on 1 Jan. 1885. It established household and lodger franchise in the counties, introduced a service franchise, and made a uniform occupation franchise of $50 rent both in counties and in boroughs in place of the three formerly existing. It left untouched the 40-shilling freeholders of inheritance, and conferred votes on copy-holders possessing land of greater value than $25 annually.

The great feature of the reform in representation was the separation of populous boroughs and counties into divisions, each returning a single member. England has now 465 members, Wales 30, Scotland 72, and Ireland 103, the reduction from 105 occurring through the disfranchisement of Sligo and Cashel some years ago for corruption.

Reformation, The. The Reformation is that movement in the 16th century which resulted in the division of Western Christendom into the Roman Catholic and Protestant Churches. Its principles, as set forth by Protestant writers, were in brief as follows: The Word of God is the final authority on all religious questions and is superior to tradition, the Pope, and the decision of general councils; a sinner is justified by faith alone. That is, he cannot obtain salvation by any amount of good works which he may accomplish, but is forgiven and saved through his faith in the work of Christ, the good works then following as a result not as a means of his salvation; a third principle is the universal priesthood of believers. This means that no mediator is needed between man and God except Jesus Christ and that all believers have direct access to Him, and that this power is not delegated to an exclusive priesthood.

For the beginning of this movement we must go back of the 16th century into the later Middle Ages. (See PROTESTANTISM.) The immediate occasion of the Reformation movement was Luther's (q.v.) controversy over the preaching of the indulgences in Germany granted by Leo X. to all who should contribute alms to the building of St. Peter's Church in Rome. Luther posted his 95 famous theses on the church door at Wittenberg 31 Oct. 1517. In these he claimed that the pope could not remit penalties beyond what he had himself imposed and also that his power did not reach beyond this life. Greatly to Luther's surprise the news of the posting of the theses quickly spread over Germany, and he found many to agree with him, but he desired only to reform certain abuses within the church, not to break away from it. But the efforts to bring about an agreement through discussion only revealed that his principles would logically carry him beyond the church. He declared the papacy a human institution, that the Council of Constance had erred in condemning Huss and that some of the fundamental teachings of the Roman Catholic Church were erroneous.

In 1520 Leo X. excommunicated Luther, who burned the bull of excommunication and a copy of the canon law, thus cutting himself off from the papacy. The new Emperor Charles V. called Luther before the Imperial Diet at Worms the next year. Luther refused to retract any of the statements in his books unless convinced by the Bible or reason. He was placed under the ban of the Empire, that is, he was declared an outlaw. On his way home from the Diet he was taken by friends to the Wartburg, a castle belonging to the Elector of Saxony, and here remained in hiding, but not in idleness, because he busied himself with the translation of tne Bible into the German of the common people. While here, extremists at Wittenberg were attempting to introduce radical reforms, and Luther returned in spite of danger and in a few days brought them to moderation, thus saving the Reformation from failure. The Reformation continued to spread through the efforts of many of the leaders in Germany, who were friendly to it and through the inability of Charles V. to give his attention to its suppression because of foreign wars. The Peasants' war (q.v.), which broke out in 1525, was ascribed by many to the teachings and position of Luther. The peasants, risen in rebellion against their rulers, believed that the time had come to strike for liberty and believed that Luther would help them, but he was opposed to their taking up arms, and the rising was put down with the loss of thousands of lives. This cost Luther many adherents and others were alienated by his marriage to a former nun in the same year. At each succeeding Diet an effort was made to come to some decision on the religious questions, but in vain. The best that could be done was the decision in 1526 to leave the matter to a general council, and until that should convene each state should use its own discretion. At the Diet of Spires in 1529, at which the Roman Catholic party was in the majority, the further progress of the Reformation was prohibited. The reformers protested against this action and received the name of Protestants. At the Diet of Augsburg in the next year the Protestants presented their confession of faith drawn up by Melanchthon, and since known as the Augsburg Confession. Reconciliation between the two parties seemed to be out of the question, and the Schmalkaldic war broke out, ending in the victory of the Protestants and the Peace ot Augsburg in 1555, by which the prince was to decide what should be the religion of the people under him, with this reservation that if an ecclesiastical prince should become a Protestant he must surrender his see.

A parallel but independent religious movement was in progress in Switzerland, under the leadership of Ulrich Zwingli. Born at Wildhaus and educated at Vienna and Basel, he came under the influence of the Renaissance and became a zealous student of the Greek Testament. Like Luther, he protested against abuses in the Church, inveighed against indulgences and tried to introduce reforms without separating from the Church. He preached at Einsiedeln and later at Zürich, with much power and attracted attention by his exposition of the Scriptures. His influence over the city government was so great that in 1523 he procured an order that the clergy of the city should preach nothing but what they found in the Scriptures and that images should no longer be used in the churches nor the sacrifice of the mass be celebrated, and in the place of the Roman Catholic forms of worship a simpler form, and as Zwingli believed, one more in accordance with the teachings and example of Christ took its place. This suggests one of the differences between Luther and Zwingli. Luther desired to keep as much as he could of the forms, ceremonies and doctrines of the Roman Catholic Church, making changes only where there seemed a direct opposition to the teachings of the Bible, while Zwingli desired to sweep away all additions and have nothing in form, ceremony or doctrine that was not directly sanctioned by the Scriptures. A conference was arranged between the two men at Marburg in 1529 that they might come to an understanding on the questions at issue between them, but on the Lord's Supper they could come to no agreement, Luther holding to the literal meaning of the words, «This is my body.» The Swiss Reformation became involved in politics, and war broke out between the Catholic and Protestant sections, in which war Zwingli was killed and the Reformation in German Switzerland became of relatively little importance compared with the work which began in French Switzerland at Geneva. The way had been prepared by Farel, a bold and successful French Protestant preacher, who had been driven from his own country by persecution. He invited John Calvin, a refugee like himself, to assist him in the work at Geneva. He accepted and began his work in 1536, and with the exception of brief intervals spent his life there, making Geneva the theological centre of Protestant Christendom. He is the theologian of the Reformation and also a great organizer. His 'Institutes of the Christian Religion,' written when he was 27 years old and subsequently enlarged, though not essentially changed, clearly sets forth the doctrines of the Reformed Church and has great influence even to the present day. He organized the church at Geneva on the Presbyterian model, because he considered this the form of organization enjoined in the New Testament. In other ways he followed Zwingli rather than Luther, though taking a position between the two in regard to the Lord's Supper. His great influence in the Reformation movement is due to his influence on the many students and refugees who came to Geneva for instruction or safety and then carried his theological system and form of government back to France, Netherlands, England, Scotland and other parts of Europe.

When Luther began his work in Germany Francis I. was king of France and the rival of Charles V. and naturally inclined to favor a movement which might injure the German Emperor. He and his court were favorers of the Renaissance and did not object to a reform of the Erasmian type. After his death the reformatory movement, now rapidly growing, was vigorously persecuted. It became complicated with political issues, and the Huguenots, as the French Protestants were called, became a political party. Catherine de' Medici, the queen-mother, with the aid of the Guises, planned and executed the massacre of the Huguenots on Saint Bartholomew's day, 24 Aug. 1572, in which Coligny, the foremost of the Huguenot leaders, was killed, and numbers of other Huguenots in Paris and the provinces. A religious war followed, which was not terminated till Henry of Navarre, the Protestant leader, gave up his faith and conformed to Roman Catholicism and secured toleration for the Huguenots in the Edict of Nantes 1598.

The Reformation quickly spread from Germany into the Netherlands through nearness, similarity in language and trade relations. Charles V. made severe laws against it, and these laws resulted in the execution of many of the Reformed faith. But he was personally popular in his home country, and there was no political party to oppose him as in Germany. When Philip II. became ruler, he made it evident that he not only would put down heresy, but proposed to rule as an absolute monarch in spite of their ancient privileges. Excessive taxes were imposed and the inquisition became more stringent. The people rallied around their nobles as leaders and revolted. Protestantism grew with great rapidity, especially in the north, but Philip resolved to subdue it, even if it meant the total extermination of the people. The best generals Spain could furnish were sent to put down rebellion and root out heresy, but these efforts were in vain. When the people could not defeat the Spaniards in open combat they cut the dikes and let in the sea. Under the guidance of their often defeated but never discouraged leader, William of Orange, the northern section, Holland, which had become almost wholly Protestant, accomplished their separation from the Spanish crown and the Roman Catholic Church. The southern part, Belgium, remained Catholic. Other countries in northern and southern Europe were affected by the Reformation. In Denmark, Sweden and Norway the Reformation was introduced by pupils of Luther and was generally aided by the authorities for advancing political interests. There was a lack of the enthusiasm which we note in northern Germany and the Netherlands, but the movement grew steadily through proximity to Germany, and these countries became and remained truly Protestant.

The Reformation extended to the south and east of Saxony into Bohemia, Poland and Hungary, carried by enthusiastic students from Wittenberg. Bohemia was prepared for such a movement by the previous labors of Huss, and here it spread rapidly. In Hungary and Poland with the Lutherans and Calvinists there were also Unitarian Protestants. The progress of the Reformation was greatly hindered by the inability of these three to work together, and their quarrels with each other. The Jesuits found this a rich field for their work in the second half of the century. Their work and the Thirty Years' war nearly annihilated the Reformation, so that Bohemia which at one time had not more than one ninth of its population adherents of the Roman Catholic Church is to-day almost wholly Catholic.

The Reformation in England was at first a personal and political revolt against the Pope rather than a religious movement. Henry VIII.

was a thorough Roman Catholic, but when the Pope refused to grant his request for a divorce he revolted against his authority, but remained essentially a Roman Catholic through his life with this exception that he did not admit the power of the Pope in England, so that this Reformation was largely negative. In the reign of Edward VI., 1547–53, there was a rapid movement toward the position of the continental Reformers, the most important events being the adoption of the Forty-two Articles as the creed of the church and the Book of Common Prayer in the English language to be used in the church service. These were both strongly Calvinistic. When Mary, the daughter of Henry VIII. and Catherine, became queen, her effort was to bring the Church back into the papal fold again and to punish the heretics. The nation through a pliant parliament returned to the Roman Catholic Church and the queen vigorously persecuted the Protestants. The leading Protestants, including Cranmer, archbishop of Canterbury, were burned at the stake, but Protestantism grew under the persecution which was ended by Mary's death in 1558. Her successor, Elizabeth, was a woman of great political shrewdness, but with little religious interest, and her effort was to make religious questions subservient to political problems. Her own preference was for a return to the relationship between church and state which existed in the reign of Henry VIII. Above all else she resolved to be supreme governor of the Church and would not tolerate those who refused to conform to the established worship. She persecuted the Puritans (as those were called who desired a form of worship stripped of the ceremonies and forms which came from the Roman Catholic Church and who refused to conform to her wishes), and also the Catholics. But she was unable to stop the growing spirit of dissent, which expressed itself in the rise of several religious parties. The Independents desired the entire separation of church and state and the independence of the local congregation. The Presbyterians thought that there should be the one state church but that it should be organized after the model of the New Testament churches which they considered Presbyterian. Still others would leave the state church as it was, only purified in form and ceremonies. The difficulty was handed down to Elizabeth's successors of the ill-fated Stuart line and reached a partial solution in the toleration act of 1689 in which the Episcopal Church remained the Established Church, but a limited freedom was given to the dissenters.

Closely connected with this was the Reformation in Scotland. Reformers from the Continent, especially from Geneva, preached and died at the stake. The leader of the work was John Knox (1505–72) who holds the position in Scotland which Luther has in Germany. He was a friend and pupil of Calvin and succeeded in establishing a church on the Geneva model in Scotland. Mary Stuart during her short reign tried to re-establish Roman Catholicism in Scotland, but found in Knox a strong and successful opponent. After the death of Knox his work was carried on by Andrew Melville.

Mention should be made of the partially successful efforts of the Roman Catholic Church to stem the tide of Protestantism and win back the lost territory. The Inquisition was so thoroughly established and did such effective work in Italy and Spain that a promising Protestant movement in both countries was stopped. There was a reformatory work carried on within the Church. In Italy the Oratory of the Divine Love was organized whose object was the moral elevation of the Church. The Council of Trent by its discussions and decisions was a reformatory influence. By it the belief of the Roman Catholic Church was clearly defined and disciplinary reforms brought about. More important than all these was the work of the new semi-monastic order, the Jesuits, who through their missionary work succeeded in gaining many thousand converts to Catholicism.

For fuller details see the following articles: Alva; Augsburg Confession; Calvin; Calvinism; Council of Trent; Cranmer; Edict of Nantes; Elizabeth; Erasmus; Huguenots; Huss; Independents; Inquisition; Jesuits; Knox; Luther; Mary Stuart; Melanchthon; Peace of Augsburg; Philip II.; Presbyterianism; Protestants; Puritans; Savonarola; Thirty-nine Articles; Wessel; William of Orange; Wyclif; Zwingli. Also consult Fisher, 'History of the Reformation' (1893); Newman, 'Manual of Church History' (1903); Walker, 'The Reformation' (1900); Jannsen, 'History of the German People' (1900); Denifle, 'Luther' (1904); Stone, 'Reformation and Renaissance' (1904); Gasquet, 'The Eve of the Reformation'; Bishop Spaulding, 'The Protestant Reformation.'

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Reformatories. See Penology.

Refor'matory Schools, schools instituted for the training of juvenile offenders who have been convicted of an offense punishable by imprisonment. The first reformatory managed under legislative control was the one established in New York in 1824, known as the New York House of Refuge. Its success was so marked that at present there are 56 institutions in the United States for the reformation of juvenile offenders. Among them are a number of admirably conducted establishments under the control of religious denominations, to which children are sent, according to the religious creed of their parents, when the same can be ascertained.

Reformed Church. See Calvinism; Dutch Reformed Church; Reformation.

Reformed Church in the United States, The, formerly known as the German Reformed Church in the United States of America and an off-shoot of the Reformed Church of Germany. The first minister was the Rev. George Michael Weise, who emigrated with about 400 people of the Palatinate in 1727, and settled in Pennsylvania. In 1746 the Rev. Michael Schlatter was commissioned by the synods of North and South Holland to visit their German missions in America, and regulate their relations. He assembled in Philadelphia the first synod or *coetus* of the German Reformed Church 1747. The German Reformed *coetus* continued under the jurisdiction of the Church of Holland till 1793, when an independent synod was formed. It increased rapidly in membership and congregations. The first triennial general synod, with jurisdiction over the whole Church, met in Pittsburg 1863. The general synod of 1869 resolved to drop the word «German» from the title of the Church. The Heidelberg catechism is the only standard of doctrine. The worship of the Church is liturgical; its government is presbyterian. Reception into the full communion of the Church takes place by the rite of confirmation. Christmas, Good Friday, Easter, and Whitsunday are observed with much solemnity. Eleven English and five German papers are published in the interest of the Church; and there are 16 theological and literary institutions under its control. Statistics, 1910: Churches, 1,737; ministers, 1,230; members, 293,836.

Reformed Episcopal Church, a denomination organized by members of the Protestant Episcopal Church, who give substantially the following statement of the events and circumstances which, as they believe, justify their course: (1) The Protestant Reformation in England had outwardly a political origin (in the act of the king, Henry VIII., renouncing allegiance to the pope, and proclaiming himself head of the English Church); by which the work was biased and cut short. During the brief life of the young king, Edward VI., the regent, or protector, being in favor of the Reformation, great progress in it was made. Under Mary the supremacy of the pope was again acknowledged. When Elizabeth became queen, wishing to harmonize her divided subjects, and hoping for reconciliation with Rome, she strove to have the liturgy framed so as to satisfy both parties. Consequently it contained contradictory elements. At a later period, when she had found her hope futile, the articles of faith adopted were decidedly Protestant. Thus it came to pass that in the Church of England two parties found support in her ritual; the one Protestant, the other having an affinity with Rome. (2) After the American Revolution, when the Church of England in the colonies became the Protestant Episcopal Church of the United States, the Book of Common Prayer, having been adopted without material alterations, retained its conflicting elements. (3) The Tractarian movement, which began at Oxford, 1833, was a successful endeavor to revive the principles of antiquity and Catholicity contained in the Prayer Book, in opposition to its Protestant elements. It discarded Protestant principles and taught the doctrines of apostolic succession, priestly absolution, baptismal regeneration, the real presence, and the authority of the Church. (4) These teachings produced a powerful effect in the United States also. A great increase in ritualism, and of the drift toward Rome, was soon manifested; the opposition between the «High» and the «Low Church» parties was intensified, and practical measures were adopted by each which widened the chasm. (5) Several subsequent public events fanned the flame of discontent, especially the censure of one clergyman for preaching in a Methodist church, and the suspension of another for omitting the word «regenerate» in the baptismal office. (6) Remonstrances and petitions for relief, which were numerously and urgently presented to the General Convention, produced no effect. (7) During the sessions of the Evangelical Alliance in New York in October 1873, Bishop Cummins of the diocese of Kentucky, having, by invitation, officiated at a union celebration of the Lord's Supper, in company with representatives of other denominations, was for this act of Christian fellowship bitterly censured through the press by members of the High Church party. After this, convinced that he could no longer rightfully continue in a Church whose theory and practice (as interpreted by the majority of its members) denied the brotherhood of believers in Christ, Bishop Cummins withdrew from the ministry of the Protestant Episcopal Church. (8) This led to the organization in 1873 of the Reformed Episcopal Church, of which Bishop Cummins and the Rev. Dr. Charles E. Cheney were elected bishops. At the same time the following declaration of principles was adopted: I. The Reformed Episcopal Church «holding the faith once delivered to the saints» declares its belief in the Holy Scriptures of the Old and New Testaments as the Word of God, and the sole rule of faith and practice; in the creed «commonly called the Apostles' Creed»; in the divine institution of the sacraments of baptism and the Lord's Supper; and in the doctrines of grace substantially as they are set forth in the Thirty-nine Articles of Religion. II. This Church, recognizes and adheres to Episcopacy, not as of divine right, but as a very ancient and desirable form of Church polity. III. This Church, retaining a liturgy which shall not be imperative or repressive of freedom in prayer, accepts the Book of Common Prayer, as it was revised, proposed, and recommended for use by the General Convention of the Protestant Church, 1785; reserving full liberty to alter, abridge, enlarge, and amend the same as may seem most conducive to the edification of the people, «provided that the substance of the faith be kept entire.» IV. This Church condemns and rejects the following erroneous and strange doctrines as contrary to God's word: (1) That the Church of Christ exists only in one order or form of ecclesiastical polity. (2) That Christian ministers are «priests» in another sense than that in which all believers are «a royal priesthood.» (3) That the Lord's table is an altar on which the oblation of the body and blood of Christ is offered anew to the Father. (4) That the presence of Christ in the Lord's Supper is a presence in the elements of bread and wine. (5) That regeneration is inseparably connected with baptism. To this statement it may be added that in this Church the bishops do not constitute a separate order, but are presbyters; in council they vote with and as their brother presbyters, and are subject to confirmation or appointment by the general council. Statistics, 1910: Churches, 80; ministers, 94; members, 9,610.

Reformed Judaism in America. See JUDAISM, REFORMED, IN AMERICA.

Reformed Presbyterian Church. See CAMERONIANS.

Reformed School of Medicine. See MEDICINE, ECLECTIC.

Refraction, a deviation in the course of a ray of light when it passes through the surface of a transparent medium. A familiar result of refraction is seen when one looks very obliquely into a transparent pool of water, of which the bottom is visible. The water seems much shallower in such a case than it really is. Another example is the bent appearance of the oars of a boat when the blades are seen obliquely under water. When ordinary light is refracted, it is also decomposed into light of the various elementary colors. This decomposition is due to the unequal refraction of light of different wave-lengths; and the resulting separation is known as *dispersion*. It is too small to be noticed in ordinary cases, such as those we have already cited. But, on looking at a source of light through a glass prism, it is very evident. See LIGHT; SPECTRUM.

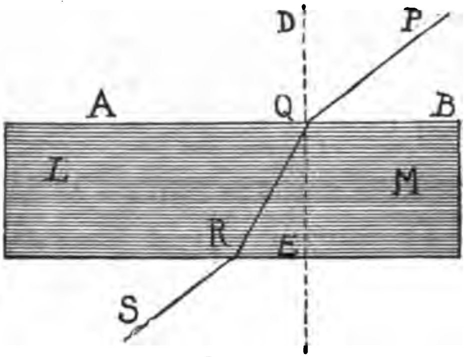


FIG. 1.

The general theory of refraction is quite simple, and may be expressed in the following way: The power of a transparent medium to refract a ray of light is expressed by a certain number called its ***index of refraction***. The phenomenon of dispersion shows that this number is different for rays of different colors, or wave-lengths. It is generally greater the denser the medium; but to this rule there are many exceptions. The mathematical principle by which the amount of refraction is determined is as follows: Let AB represent the surface of a transparent medium, LM. Let a ray of light, PQ, strike this surface obliquely at Q and enter the medium, and let QR be its course through the medium. Draw through Q the perpendicular DE. Then the angle PQD which the ray makes with the perpendicular before it enters the medium is called the ***angle of incidence;*** and the angle EQR which it makes after entering the medium is called the ***angle of refraction***. The law of refraction then is:

For one and the same medium, and the same ray of light, the ratio of the sine of the angle of incidence to that of the angle of refraction is a constant quantity for the same medium and the same ray.

This constant ratio is called the ***index of refraction***. The law may be expressed in algebraic language as follows: Put

I, the angle of incidence;
R, the angle of refraction;
n, the index of refraction.

Then we shall have

$$n = \frac{\sin I}{\sin R}$$

or,

$$\sin R = \frac{\sin I}{n}$$

It is a law of the course of light that, if a ray passes in the opposite direction, say from R to Q, it will continue on the line QP after leaving the medium. It follows if the ray PQ emerges from the medium at R it will suffer refraction according to the same law as a ray entering it, but in the reverse direction. Hence if the lower surface of the medium is parallel to the upper surface, the emerging ray RS will be parallel to PQ.

One result of the above law is that a ray entering or leaving a medium in a direction perpendicular to the surface of the latter will undergo no refraction, but will continue in the same straight line. In this case the angles of incidence and refraction are both zero.

From the above equation we find that, if the angle R and the index of refraction are given, we can find the angle of emergence by the equation

$$\sin I = n \sin R.$$

Now, the angle R may be so large that this expression is greater than 1. Then there will be no possible value of the angle of emergence to fulfil the condition. It is found that, in this case, the ray will not emerge from the medium at all, but will be reflected from its inner surface as if the latter were polished and opaque. This is called ***total reflection***, and is frequently applied in optical instruments. An example will show how this result may be brought about. Let ABC, Fig. 2, be the section of a glass prism, the angle at C being a right angle. Let a ray enter the prism at the point Q in a direction perpendicular to the surface BC. It will then pass on and will reach the lower surface of the prism at the point R. The angle DRQ will then be 45 degrees. The sine of this angle is 0.707 +. Now, a glance at the table which follows will show that in all sorts of glass the index of refraction is greater than 1.5. It follows that the sine of the angle at which the ray QR should emerge from the prism would be greater than 1.5 × 0.7, and therefore greater than 1. There is then no possible angle to fulfil the conditions. The light is therefore reflected in the direction RS, as though the surface AB were perfectly opaque and highly polished.

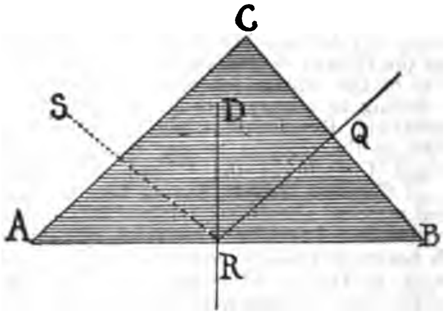


FIG. 2.

Indices of Refraction of Various Substances. — Any one definite chemical compound has, at a given temperature, always the same index of refraction for the same ray. But glass is not such a compound, because its ingredients differ in different specimens of glass. It is impossible to make two pots of glass so exactly alike that they shall have the same index of refraction. It is owing to this fact that the idea frequently entertained, of making a telescope by putting together different pieces of glass, is impracticable. The following table shows the indices for a number of common transparent substances, and for three of the principal rays, C, D, F. It will be seen that glass has a greater refracting power than water; and that plate glass is more refracting than crown. The diamond is the substance which has the greatest refracting power of all. It has also a great dispersive power; and it is owing to this fact that a diamond with polished faces shows so many brilliant colors when a ray of light falls upon it.

TABLE OF INDICES OF REFRACTION.

	Ray C	Ray D (mean)	Ray F
Soft crown glass....	1.511910	1.514580	1.520994
Medium crown glass.	1.513558	1.516149	1.522343
Hard crown glass...	1.514571	1.517116	1.520994
Light flint glass.....	1.537682	1.541022	1.549125
Medium flint glass..	1.575903	1.579880	1.589870
Dense flint glass....	1.645773	1.651242	1.664981
Rock salt	1.54050	1.54418	1.55324
Iceland spar	1.65435	1.65833	1.66780
Rock crystal	1.54190	1.54424	1.54970
Fluor-spar	....	1.4339	....
Canada balsam	1.528	....	....
Diamond	....	2.470	....
Ice	1.306	....	....
Quartz	....	1.5442	....
Water	1.3307	1.3324	1.3366
Carbon sulphide.....	1.6240	1.6333	1.6584
Air	1.000290	1.000292	1.000294

The refractive power of a substance is different at different temperatures. As a general rule, glass refracts more the colder it is. Consequently the focal length of a telescope will generally be slightly shorter the colder the weather. The difference is, however, slight and there are exceptions to the rule.

Refraction by the Atmosphere.— It will be seen by the preceding table that air has an appreciable, though slight, refracting power. It follows that a ray of light coming from a star is gradually bent toward the perpendicular as it approaches the surface of the earth. Only when a star is in the zenith does the ray suffer no refraction. The result is that astronomical observations upon the declination or altitude of a heavenly body require to be corrected for refraction. The latter, depending upon the density of the air, is greater the colder the air and the higher the barometer. Hence the astronomer has always to record the readings of his thermometer and barometer when he observes the altitude of a heavenly body. A rough approximation to the amount of the refraction can be made by the rule that, at small zenith distances it is nearly 1″ for each degree of zenith distance; and that, if the altitude is not greater than 45°, it increases nearly as the tangent of the zenith distance. The rate of increase is somewhat less than that given by this law, but still the refraction increases rapidly as we approach the horizon, where it usually amounts to about 35′. This is greater than the diameter of the sun or moon. It follows that, when we see the lower limb of the sun just touching the horizon at sea, the luminary is actually entirely below the horizon. Moreover, the lower limb is elevated more by refraction than the upper one, with the result that a certain ellipticity is produced in the apparent outline of the sun, which is plainly perceptible to the naked eye.

A ray of light always suffers refraction when passing through the air in any other than a vertical direction, and its course is most curved when it is horizontal. In this case the curvature under ordinary conditions of the air is about 1/6 that of the earth. But this result depends entirely at the rate of increase or diminution of the temperature as we rise above the ground. If the air is very cold near the ground, and rises rapidly in temperature above it, a horizontal ray may be more curved than the earth, and strike the latter at some point. Objects may then be seen at such a distance that they are far below the horizon, as was once noticed by an Arctic navigator who, when separated from one of his ships, saw her image upside down above the horizon and, sailing toward it, found the ship. In the contrary case, when the air near the ground is much warmer than at a small height above it, the reverse effect is produced. A horizontal ray is then refracted upward so as not to strike the earth at all. It is through this action that the mirages, so frequent in the desert and elsewhere, are produced. See MIRAGE.

S. NEWCOMB.

Refrigeration and Refrigerating Machinery. Refrigeration is the operation of cooling substances by artificial means. Natural ice forms the greatest source of refrigeration, but there are certain conditions where cold produced through mechanical means possesses advantages over natural ice, which have led to the development of a number of refrigerating machines. The advantages of mechanical refrigeration over that produced by natural ice are that the temperatures of the objects cooled can be more readily regulated, lower temperatures can be obtained, and in many cases the desired cooling effect can be secured at a lower cost. Refrigerating machines are used in cold storage warehouses, and allow the temperatures of the rooms to be readily adjusted so that their contents are either frozen or held at temperatures slightly above the freezing point. They are extensively used in various manufactures such as brewing. There are also numerous plants for the production of artificial ice, which possesses hygienic advantages over natural ice when used in such a way as to bring it in direct contact with food or drink, in that it may be made free from bacteria; whereas the natural ice holds those originally in the water without destroying them. Many bacteria can even withstand the extreme cold produced by liquid air of about 300° F. below zero without losing their vitality.

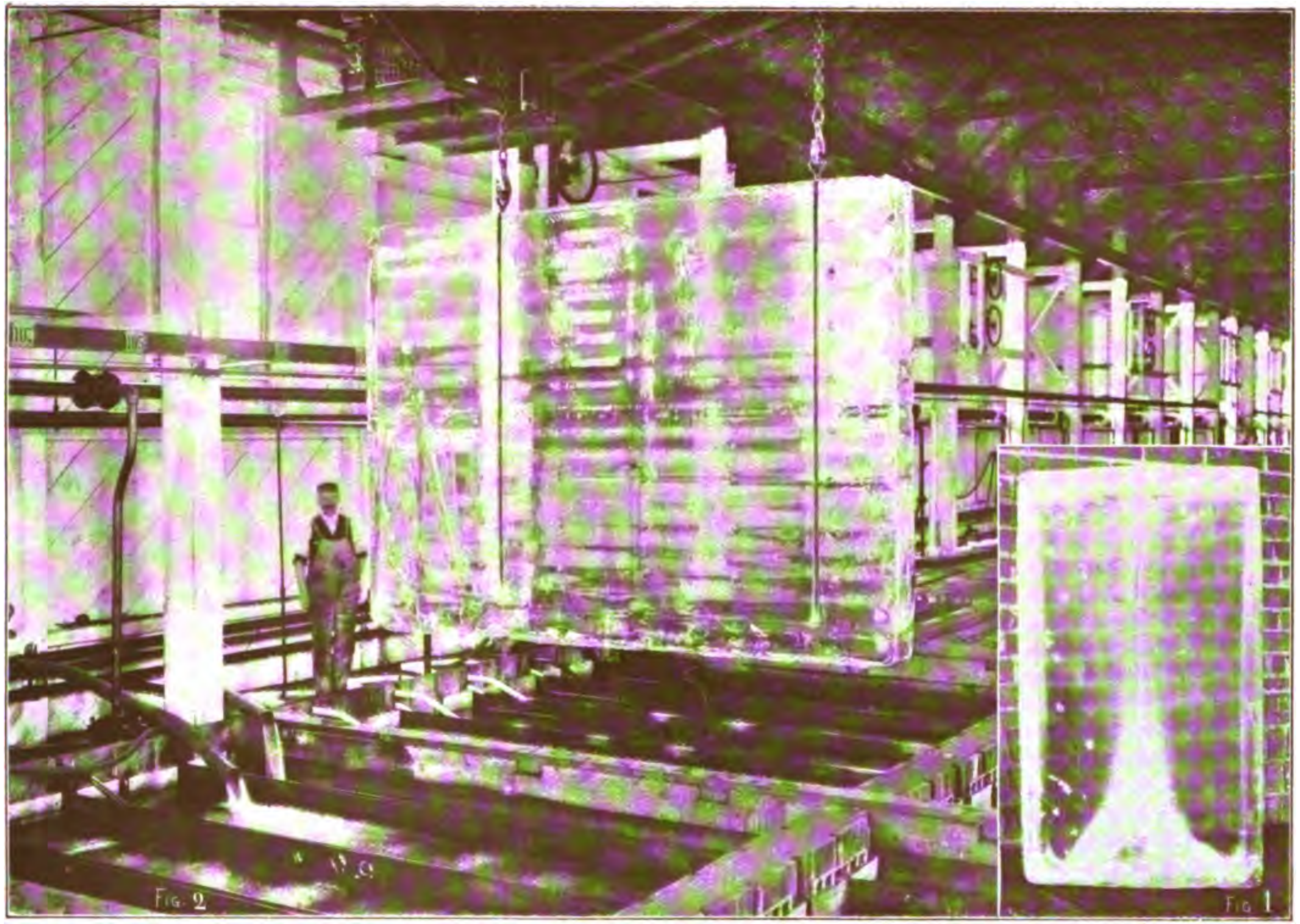
Ice as a Refrigerant.— With the present mode of life ice is a domestic and commercial necessity. And yet the extended use of ice in many fields is of comparatively recent origin. Nero had ice houses constructed in Rome, and ice houses for storing natural ice have been in use for centuries, yet it is but a short time since refrigerating cars have made it possible to ship Western beef to New York and the fruits of California to any part of the United States.

Ice-making.— The production of artificial ice. The heat is usually abstracted from the water to be frozen by evaporating a volatile liquid, such as ammonia, sulphur dioxide, or ether, which in evaporation absorbs heat. Anhydrous ammonia is most commonly employed. This boils at 27° F. below zero at atmospheric pressure. If the anhydrous liquid ammonia is introduced in a coil of pipe which is placed in a tank of brine it will absorb heat from the brine during the process of boiling equal to the latent heat of evaporation. If a can of water is immersed in the brine it will in turn be cooled and then frozen, and this process constitutes the elements of the Can System of ice-making. If on the other hand, the ammonia in the coil is made to cool a flat plate forming the vertical side of a water reservoir ice will be formed directly on the plate, and this constitutes the elements of the Plate System of ice-making. The vapor produced when the liquid ammonia evaporates in the coil, is, in all cases, again converted to the liquid state so that it may be used over again. In abstracting heat from the refrigerating coil the vapor is at a low pressure, say 15 pounds per square inch above the atmosphere at which the boiling point of the liquid is 0° F. To convert it to a liquid it must be raised in pressure, to say 140 pounds per square inch above the atmosphere, at which the boiling point of the liquid is 80° F. As the temperature at the boiling point of a vapor is the same as that at the condensing point, the vapor at 140 pounds pressure can be condensed by cooling it to 80° F., and after such condensation it may be returned to the refrigerating coils and used over again for abstracting heat from the brine. To raise the pressure of the gas from 15 pounds to 140 pounds per square inch we may employ either of two methods — compress it by means of an engine, or we may absorb the vapor in cold water and then heat the aqueous solution of ammonia in a still, and so drive the gas off at high pressure. These two methods of compression constitute the distinguishing features of what is called the compression and absorption systems of ammonia refrigerating machines.

In the can system of ice-making, distilled water which has been freed of air is ordinarily used for freezing and this produces a cake of transparent and clear ice with the exception of a thin feather of air bubbles in the centre of the cake and a portion of the top of the cake which is white where the water expands over that first frozen. A cake of ice made by the can system is shown in Fig. 1. The distilled water from which ice is made is obtained by condensing the exhaust steam from the engine of the refrigerating machine and by condensing live steam. In an economical plant the steam required to run the engine and for other purposes is less than the amount of ice produced, and to make up the difference some live steam is admitted directly to the condenser in order to supply the necessary amount of distilled water. In an ice-making plant where the water is distilled by evaporating it in an ordinary boiler, the weight of ice made per pound of coal is, therefore, limited by the evaporation of the boiler and the amount of ice produced is less than the total amount of steam generated by what is lost through the drips from the steam pipes and other causes. It is possible, therefore, to make more ice per pound of coal by the plate system of ice-making where the water is not distilled than it is by a can system as ordinarily operated. In an economical compression plant where the ice is made by the can system a single cylinder engine working without a vacuum will require less steam to run it than the weight of ice which is produced, and if distilled water is used for freezing it will not increase the efficiency to employ a more economical engine. In a plate system, however, a compound engine may be used with a corresponding gain in the efficiency.

In order to make it possible in a can system to make a greater amount of distilled water ice than the weight of water evaporated by the boiler it has been proposed to use multiple-effect evaporators for distilling the water. This was done in a plant at Newark, N. J., but the system had to be abandoned on account of the evaporator becoming coated with a hard scale which was deposited from the water to such an extent that the evaporator soon fell off in its capacity and efficiency. Where the steam from the engine operating the refrigerating machine is condensed in order to obtain distilled water for making the ice, the oil which this water contains must be eliminated. This is accomplished by re-boiling the water which comes from the condenser in an open tank by means of a jet of live steam; then cooling and running it through an oil separator and finally through charcoal filters. Reboiling the distilled water removes the air which it may contain. It is possible to so thoroughly remove the oil that there will be no traces of it in the ice, whereas, if this is done imperfectly, the centre of the cake, when freshly broken open, will have a slight smell resembling that of tar. The presence of a trace of oil can be detected by the odor when it cannot be detected by taste. In the plate system the ice is formed on the flat cooling surface to the depth of about 6 inches in 2 days, 9 inches in 4 days, and 12 inches in 7 days. The plates on which the ice is frozen are about 10 by 14 feet in area. A cake of ice which has just been drawn or harvested from the tank of a plate system is shown in Fig. 2. The plates are usually allowed to build up to about 12 inches thick before harvesting. They are then melted free from the cooling plate by passing hot ammonia gas under pressure into the cooling coil which by condensation supplies the necessary heat. After this the blocks of ice are cut to the size required by sawing or by a parting tool heated by steam. In some plate systems cold brine instead of ammonia is circulated through the cooling coils. In the plate system the water in contact with the freezing plates is agitated by means of compressed air which is admitted from a perforated pipe placed near the bottom of the tank. As the ice freezes from one side only it forces the impurities and the air contained in the water to its surface, and the circulation produced by the air bubbles floating upward through the water assists in removing the impurities and air bubbles from the surface. A clear transparent ice is thus produced

The results of tests of a can and a plate system of ice-making are given in Table I., which follows. The test of the can system was made by Messrs. Hupfel, Griswold and Mackenzie of the class of 1893 of the Stevens Institute of Technology as a graduation thesis. The plant was that of the Hygeia Ice Company, New York. The tests of the plate system were made by Messrs. Warner, Moore, Hunt, and Quick of the class of 1904 of the Cornell University as a graduation thesis, the tests being made on the plant of the Diamond Ice Company at Wilmington, Del.



REFRIGERATION AND REFRIGERATING MACHINERY.

TABLE I.— RESULTS OF TESTS OF TWO ICE-MAKING PLANTS, ONE USING THE CAN SYSTEM AND THE OTHER THE PLATE SYSTEM.

	Can system	Plate system
Fuel used[*]	Buckwheat and pea	Bituminous coal
Type of engines driving compressors	Simple	Compound
Total ice made per pound of coal as fired	7.28	11.02
Percentage of ice lost in removing from cans or in harvesting and cutting	2.2	12.0[†]
Net ice made per pound of coal as fired in pounds	7.12	9.70
Total ice in pounds per hour per horse-power of steam cylinder.	38.6	37.9
Net ice manufactured per day in tons of 2,000 lbs., compressors of can system running 12 hours per day, and of plate system 24 hours per day	97	109
Average pressure of ammonia gas at condenser in pounds per square inch above the atmosphere	135.2	118.6
Average back pressure of ammonia gas in pounds per square inch above the atmosphere	15.8	9.1
Pounds of water evaporated at boilers per pound of coal	8.085	8.02
Total horse-power developed by compressor engines	444	274

APPROXIMATE DIVISION OF STEAM IN PER CENTS OF TOTAL AMOUNT.

Compressor engines	60.1	69.6
Live steam admitted directly to condensers	19.7	0
Steam for pumps and auxiliaries.	7.6	25.1
Live steam for re-boiling distilled water	6.5	0
Steam for blowers furnishing draft at boilers[‡]	5.6	0
Steam for dynamo engines[‡]	0	2.9
Steam for removing ice from cans and for harvesting and cutting the ice	0.5	2.4

[*] The calorific value of the coal used in the two tests was about the same.

[†] This loss is excessive and with a proper system of cutting could readily be reduced to about one half, which would make the net produced per pound of coal 10.4 pounds instead of 9.7 pounds.

[‡] The blowers and dynamo engine are not necessary adjuncts to the ice-making plants, and the steam used by them should be eliminated from the comparison. One of the items tends to counterbalance the other, however, so that the comparative figures for the performance of the two plants are fair ones.

In the so-called vacuum ice-making machines water is used as a working fluid, and it is cooled to the freezing point by its own evaporation. In these machines the water is injected into a refrigerating chamber in which a vacuum is maintained and a portion of the water is frozen by the cooling effect produced by the evaporation. In some machines the vacuum is maintained entirely by mechanical means and in others by the combination of an air pump and a reservoir of strong sulphuric acid for absorbing the water vapor. Where acid is used it is heated after it has become weak through the absorption of water vapor and after concentration is returned to the machine and used over again as an absorbent. Where a vacuum is maintained entirely by mechanical means a very large cylinder displacement is required in the air-pump. One machine constructed on this principle had a cylinder 20 feet in diameter and a stroke of 10 feet, and made 20 double strokes or revolutions per minute. The ice produced is white, opaque and hard. It is produced in large cakes and cut by a saw to the size required for commercial use.

Ammonia Compression System with Brine Circulation.— Fig. 3 shows a compression system for a cold storage warehouse. A is the compressing cylinder which is driven by the steam engine B. The gas on being compressed in A passes up through the pipe *aa* to the condenser C, where it is liquefied. The liquid anhydrous ammonia passes from the condenser through the pipe *bb* to the liquid ammonia reservoir D. From the reservoir D the liquid ammonia passes through the valve E, termed "the expansion cock," where it is reduced in pressure from say 140 pounds per square inch above the atmosphere to a pressure of say 15 pounds per square inch above the atmosphere, and thereby is reduced in temperature from about 80° F. to about 0° F. The anhydrous ammonia at a temperature of about 0° F. flows in coils of pipe in the brine cooling tank F, and abstracts heat from the brine by being evaporated. The gas produced by the evaporation of the ammonia passes from the condenser coils through the pipe *cc* to the compressing cylinder A, where it is again compressed and returned to the condenser. The brine which is reduced in temperature in the cooler F is pumped by means of the pump G through the pipes *dd*, which are connected with coils HH in the cooling rooms II. After the brine has passed through the cooling coils it is returned to the cooler F. In passing through the expansion cock E about 10 per cent of the weight of the anhydrous ammonia will be vaporized and it is the heat required to produce this vaporization that causes the liquid to be reduced in temperature from say 80° F. before throttling to 0° F. after throttling. Ninety per cent of the ammonia is, therefore, in the liquid state when it has attained the temperature of ebullition corresponding to the pressure existing in the cooler. The brine in the cooler is at a slightly higher temperature than the liquid ammonia contained in the coils and transmits heat to it so as to boil it and convert it into gas. The brine in parting with its heat is thus cooled to the extent of the heat required to evaporate 90 per cent of the liquid ammonia which passes through the throttling cock. In some types of compression machines all of the ammonia is not allowed to vaporize in the cooler, whereas in other systems care is taken to secure a complete evaporation. This gives rise to two classes of machines, one of which is known as the wet or cold compression and the other as the dry compression system. The brine returns to the cooling tank after passing through the storage rooms at about 6° higher temperature than that at which it leaves the cooler and the mean temperature of the brine is about 10° higher than the boiling point of the ammonia corresponding to the suction-pressure. The mean temperature of the brine is 6° less than that of the air in the storage rooms. For the storage of beer a temperature of about 36° F. is required, and this is secured with a pressure of about 28 pounds per square inch above the atmosphere in the coils of the cooler. Slaughter houses require about 25° F. in their storage rooms, which must be obtained by a pressure of about 22 pounds per square inch in the cooler. The storage of fish requires a temperature of about 0° F., for which a pressure in the brine coils of the cooler of about 5 pounds per square inch above the atmosphere must be used. Instead of a brine made with ordinary salt one formed from chloride of calcium is often used as a circulating medium because it produces less corrosion in the pipes than salt brine and may be brought to a lower temperature before it freezes or becomes partly congealed. In another system air is blown around the coils of the cooler and is circulated through the storage rooms, and a chamber freshly filled with material can be more quickly cooled than by the use of cooling coils. The air system appears to be more expensive to operate than the brine system.

Direct Expansion Systems.— In some machines instead of expanding the ammonia in coils placed in the cooler and forcing cold brine through the coils in the refrigerating rooms the anhydrous ammonia is expanded directly in coils placed in the refrigerating rooms. In this system we eliminate the loss due to the difference in temperature between the brine and the coils in the cooler. The use of brine is, however, regarded by many as a safeguard against damage to the material in the store room by the accidental escape of ammonia from the circulating pipes; the brine circulation is for this reason much used, notwithstanding the fact that the cost of the piping is less for the direct expansion system and that there is a saving in the cost of operation. This saving is due to dispensing with the brine circulating pump and permitting from 5 to 10 pounds higher pressure to be used in the coils of the cooler. In the wet system of compression, known also as the Linde system, the presence of liquid ammonia in the compression cylinder limits the highest temperature attained by the ammonia during compression to the boiling point of the ammonia liquid corresponding to the highest pressure, or say to 80° F. With the dry system of compression the maximum temperature in the compression cylinder is about 100° F. higher than this, and if the cylinders were non-conductors of heat the wet process would be more economical than the dry. It appears by tests, however, that the influence of the conductivity of the cylinder walls in abstracting heat in one part of the cycle and giving it back in part in another, makes the two systems about equal in economy.

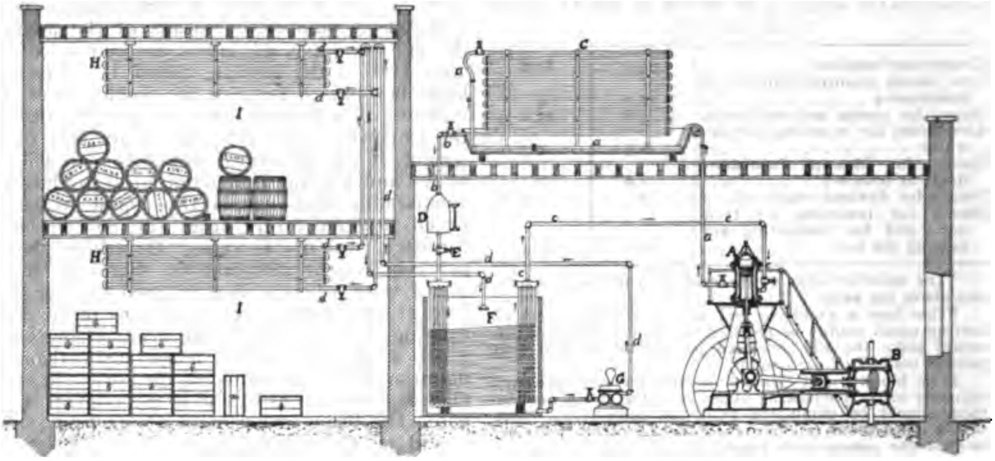


FIG. 3.

Ammonia Absorption System.— As has already been explained, the essential difference in an absorption machine and a compression machine consists in the method of increasing the pressure of the ammonia gas leaving the refrigerating coils. For the compressing pump and the steam-engine in the compression system there is substituted a vessel called an absorber, and a pump for pumping the liquid into a steam still. The condenser, liquid ammonia reservoir, expansion cock and cooler are the same in the two systems. A section of an absorption refrigerating machine is shown in Fig. 4. A is the still or generator in which the aqueous ammonia is heated in order to drive off the gas. The ammonia gas passes off through the pipe *aa* to the rectifier B, where the gas is cooled to a point where any water vapor in it will be condensed. The ammonia gas free from water vapor passes to the condenser C, where it is condensed and passes through the pipe *bb* to the ammonia reservoir D. From the reservoir D the liquid ammonia passes through the valve, or expansion-cock E, into a refrigerating chamber or cooler F, where it is evaporated through heat supplied by the coils contained therein through which a calcium chloride brine is circulated. The cold brine is circulated through the pipes *dd* to and from coils in the cold storage rooms. The ammonia gas leaves the cooler through the pipe *cc* and enters near the top of the absorber J, where it meets a spray of weak ammonia liquor, which is conducted to it through the pipe *ee*. The ammonia gas is taken up by the weak ammonia liquor in the absorber and forms the strong liquor which leaves the absorber through the pipe *ff* and is forced by the pump K through the pipe *ll*, the exchanger L and the pipe *mm* into the top of the generator, thus completing the cycle. Heat is given off by the ammonia on absorption, which is taken up by water circulated through coils contained in the absorber. The exchanger L saves heat which would otherwise be lost, and thus increases the efficiency of the machine. The weak liquor on leaving the generator is at the highest temperature at which the aqueous ammonia is brought in the system, whereas the strong liquor leaving the absorber is at the lowest temperature. It is necessary to cool the weak liquor before it enters the absorber and to heat the strong liquor to the temperature of the generator, and this is accomplished, in part, by the exchanger by making the weak liquor heat the strong liquor and the strong liquor cool the weak liquor. The weak liquor at about 270° F. is taken off near the bottom of the generator and passes through the pipe *nn* to the top of the exchanger L and thence through a coil contained therein. From the bottom of the exchanger it passes through the pipe *ee* to the absorber J. The strong liquor at about 130° F. passes through the exchanger L in the reverse direction to that of the weak liquor, and the interchanging of heat is such that the weak liquor leaves the exchanger say 100° F. cooler than it entered and the strong liquor is heated a corresponding amount. The strong liquor is made to enter the top of the generator and pass through what is called an analyzer M. The analyzer adds to the efficiency of the generator by causing the strong liquor to meet the outgoing gas generated at the bottom of the still. An exchange of heat takes place, which causes much of the ammonia contained in the strong liquor to be driven off at a lower temperature than that which exists at the lower part of the still and produces ammonia gas more free from water vapor than could be secured if the strong liquor were introduced into the lower part of the still. The cooling water passes first through the condenser C, entering through the pipe *oo* and from thence to the absorber J through the pipe *pp*. It finally leaves the absorber through the pipe *qq*. Heat is supplied to the generator by means of steam which enters a coil contained therein through the pipe *rr*. The water vapor condensed in the rectifier together with the ammonia which it carries with it is returned to the analyzer by means of the pipe *ss*. The drip water from the generator coil is discharged through the steam trap N.

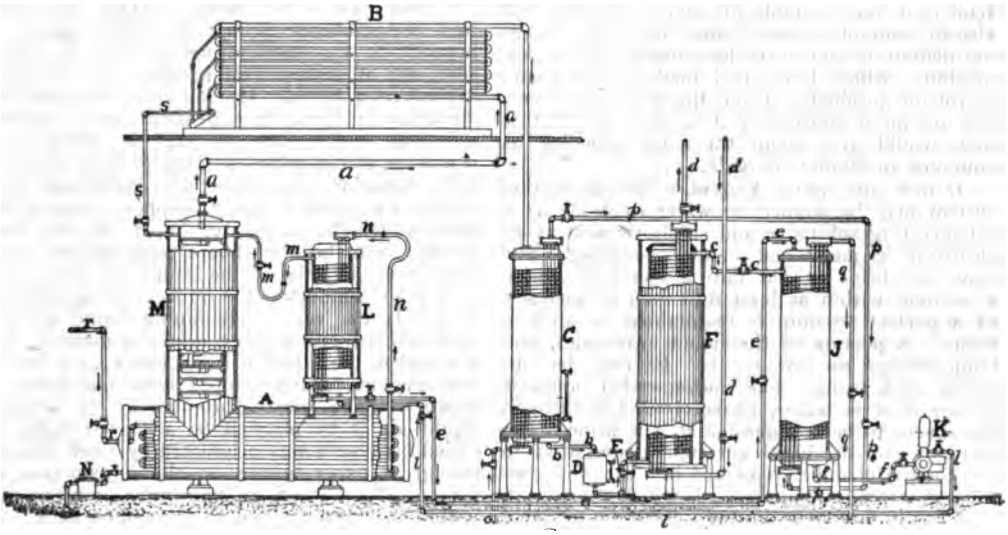


Fig. 4.

Comparison of Ammonia Compression and Absorption Systems.— Tests have shown that the economy of a compression system when driven by an engine requiring 3 pounds of coal per hour per indicated horse-power is about equal to that of the best absorption system when used in connection with a boiler of good efficiency provided the suction pressure of the ammonia gas is about 20 pounds per square inch above the atmosphere — that is when the temperature of the substance to be refrigerated is about 20° F. For higher temperatures and higher suction pressures the compression machine is more economical in fuel, and for lower temperatures the absorption machine is more economical, unless the compression system employs a multiple expansion engine so as to reduce the coal consumption below the 3 pounds on which this comparison is based.

Other Compression Systems.— Water, sulphuric ether, sulphur dioxide, carbonic acid, methylic ether, and certain petroleum products may be used in compression systems in the same way as ammonia. In the case of water temperatures colder than 32° F. require a suction pressure of within .08 pound per square inch or 0.16 of mercury of a perfect vacuum. The dimensions of a compressor cylinder of such a plant is about 150 times that for ammonia. The use of water as a working fluid is, therefore, impracticable except for the production of ice as described under *Ice-making*. Sulphuric ether was the first substance practically applied to refrigeration by the compression system. The volume of the compressing cylinder is, however, about 17 times that required for ammonia, and its use has, therefore, been abandoned. Sulphur dioxide machines produce a temperature of about 5° F. in the cooler with a suction of about 3 pounds below, and a condenser-pressure about 35 pounds per square inch above the atmosphere. Their economy is about the same as with ammonia, but the compressing cylinder must be about 3 times as large as for ammonia. The Pictet system uses sulphur dioxide, and in some cases what is called the Pictet fluid, which is sulphur dioxide mingled with about three per cent of carbonic acid. Carbonic acid gives a temperature of 5° F. in the cooler with a suction-pressure of about 330 pounds per square inch above the atmosphere and a condenser pressure of about 900 pounds per square inch. The fuel required is more than with ammonia, but the size of the compressor cylinder is about one fourth that required for ammonia. Carbonic acid is used only to a limited extent; but the compactness of the machine employing it, together with the fact that any bursting of a pipe or leakage will not lead to the same disastrous results as with ammonia, renders it more suitable for service on ships and also in some other special lines of work. Nothing definite is known of the economy of the few machines which have used methylic ether and petroleum products. From the physical properties of these substances it would appear that they would give about the same economy as ammonia or sulphur dioxide.

Water Absorption System.— The absorption system may be applied to water or brine as a refrigerating substance and sulphuric acid as an absorbent as mentioned under *Ice-making.* The water or brine is fed into a chamber, where a vacuum within at least 0.16 inch of mercury of a perfect vacuum is maintained by an air-pump. A portion of the liquid evaporates, and temperatures as low as 14° F. may be obtained with brine. The unevaporated liquid is frozen if it is water, or is circulated through the spaces to be refrigerated if it is brine. The water vapor produced through evaporation in the cooling chamber is passed into a vessel containing strong sulphuric acid, which absorbs it, and finally becomes diluted. The diluted acid is pumped into a still or generator, where it is heated and converted to a strong acid, which is used again in the absorber. This method was employed in one of the oldest forms of ice-making machines where a vacuum was produced in a glass bottle or caraffe filled with water and ice was formed inside the bottle for table use. Other substances having a strong affinity for water may be used in place of sulphuric acid. About one fourth of the water is vaporized and the remaining three fourths is converted into ice.

Air as a Refrigerant.— When air at ordinary pressures is used as a refrigerant, the expansion cock marked E in Figs. 3 and 4 must be replaced by a cylinder and piston in which the air in expanding can be made to do work. If air at say 100 pounds pressure above the atmosphere is allowed to enter the cooler through the expansion cock, there would be practically no refrigeration produced. The reason for this is that air at ordinary pressures behaves like a perfect gas. To lower the temperature of the air to any material extent it must be made to do work against a piston. An expanding as well as a compressing cylinder must therefore be provided. The work done by the expanding cylinder may be made to help drive the compressing cylinder. In an air machine having a condenser pressure of 45 pounds per square inch above the atmosphere the volume of the compressing cylinder would be about 20 times that required by an ammonia machine, and the temperature of the air on leaving the expansion cylinder would be about 50° F. below zero. The consumption of fuel for a given refrigerating effect would be about 6 times that of ammonia. If instead of using air at atmospheric pressure a closed system is used, so that the pressure on entering the compression cylinder is about 40 pounds per square inch above the atmosphere, the volume of the compressing cylinder is reduced to about 6 times that required for ammonia, but the economy is about the same as where the air is used at atmospheric pressure. Air machines are used extensively on ships because the use of air does not involve the risk of the cargo through leakage.

Liquid Air.— Air under certain pressures and temperatures is not a perfect gas. If brought to the temperature of 312° F. below zero, air at atmospheric pressure will be condensed to a liquid. Having once obtained the liquid air at atmospheric pressure and its corresponding temperature of 312° F. below zero it may be placed in an open vessel from which it will evaporate only after a considerable time if simply exposed to the atmosphere, because the portion which evaporates must absorb heat energy from the atmosphere equal to the latent heat of evaporation of the liquid air, and as air is a poor conductor the process is necessarily slow. If the vessels containing liquid air are well covered with a non-conducting material, but not sealed, the liquid will evaporate very slowly and may be readily shipped from one point to another. The most efficient way of keeping liquid air is to place it in a Dewar bulb, so called because it was originated by Prof. Dewar, the great experimenter on the liquefaction of gases. This consists of two bulbs of glass, one within the other, joined to a common neck. In the space between the two bulbs there is a very high vacuum which prevents heat being conducted to the inner bulb. The outside of the inner bulb is silvered with mercury in some cases, and this reflects much of the radiant heat, and a bulb of this sort will hold the liquid air longer than one which is not silvered. A silvered bulb holding 5 quarts has been known to hold liquid air for 29 days before it completely evaporated. Ordinarily, liquid air in cans or vessels insulated with non-conductive coverings and holding 10 gallons or upward can be transmitted by train for say two days with a loss of about 25 or 30 per cent. This has led to the proposition to employ liquid air as a commercial refrigerant, but its cost has so far prohibited its use for this purpose. The very low temperature attainable with liquid air makes it seem that some use may be found for it in the arts which will warrant employing it even if it must be supplied at a high cost. It has been proposed to separate the oxygen from the liquid air for commercial use. The method first employed to liquefy air and other gases was to use the liquid from a gas which is readily liquefied to cool a second gas while under pressure and so liquefy the second gas. Then to start with the liquid from the second gas to liquefy a third and so on. It was shown later that if air were compressed to about 2,500 pounds per square inch and made to pass through a coil to a throttling cock, liquid air could be produced by causing the cold air leaving the throttling cock to pass over the coil so as to cool the incoming air, thus producing a lower and lower temperature at the throttling cock until liquid air appeared and was drawn off from the apparatus. In an apparatus of this sort the weight of liquid air produced was about 5 to 7 per cent of the entire weight of air compressed. In this type of apparatus all the work done by the free expansion of the air is lost, and there is a field open to development by eliminating this loss and at the same time increasing the refrigerating effect.

Performance of Refrigerating Machines.— The performance of a refrigerating machine is measured by what is termed the «ice-melting effect,» which is obtained by dividing the amount of refrigeration measured in British thermal units by the latent heat of fusion of ice, which is 142.2. This represents the number of pounds of ice which would have to be melted in order to produce the same refrigerating effect as the machine in question. The number of tons of ice which a given machine produces in 24 hours is also another common unit, but this cannot be made an absolute unit of refrigeration, because the amount of ice produced depends upon the temperature of the water frozen, the losses due to radiation at the freezing tank, etc. The theoretical performance of a compression refrigerating machine is found by computing the piston displacement per minute, and from this determining the weight of gas at the suction pressure which would be drawn into the cylinder and discharged for full displacement. From the law of compression of ammonia gas the horse-power developed in compressing the gas to the pressure existing in condenser is computed, and by adding the friction of the machine the horse-power necessary at the steam cylinder is determined. The cooling effect in British thermal units is computed by subtracting from the total heat of the liquid at the pressure existing in the refrigerating coils the sensible heat of the liquid at the condenser pressure. By reducing this to the equivalent ice-melting effect and dividing by the coal required to develop the horse-power in the engine cylinder we obtain the ice-melting effect per pound of coal.

Table II. gives the results of such computations and compares them with the results actually obtained in tests of refrigerating machines. It may be seen that in all cases the theoretical performance is greater than the actual. The difference is caused by loss due to heating the gas on entering the compressing cylinder, to radiation, and to friction and wire drawing at the inlet and exit valves.

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Refrigerator, a machine or apparatus employed to reduce temperature by chemical or mechanical means. In the restricted sense in which it is most familiarly understood, the term refers to any vessel or chamber in which animal and vegetable substances, solid or liquid, are kept, and are prevented from decaying or fermenting, by the presence of ice, or freezing mixtures, or by the circulation of currents of air or liquid furnished by a refrigerating machine. Domestic refrigerators of this character are made in a great variety of forms, ranging from the common metal-lined wooden ice-box, provided with a tube to drain off the water from the melting ice in the ice chamber, to the large and elaborate ice-rooms used for extensive storage purposes.

Refrigerator cars employed to transport perishable merchandise without deterioration over long distances may also be considered as belonging to this class. They were first operated in 1867, between Chicago and New York city, and succeeded in keeping the meat transported fresh and sweet through an interval of 10 days, during the hottest summer months. Each end of a car is provided with a chamber in which blocks of ice are packed on gratings in such a manner as to permit the circulation of a current of air, furnished by a blower driven by a belt on one of the axles, over the ice and through the storage space in the car.

Domestic Refrigerator.

Refuge, Cities of, six Levitical cities divinely appointed as places of refuge to one who had committed manslaughter, and was pursued by the «Revenger» or «Avenger» of Blood. Three (Kedesh Naphtali, Shechem, and Hebron) were west of the Jordan, and three (Bezer in Reuben, Ramoth Gilead in Gad, and Golan in the half-tribe of Manasseh) were east of that river. If the case was proved to be one of murder, the perpetrator might be taken from the City of Refuge and put to death; if it was only manslaughter, the refugee had to remain in the city to which he had fled till released by the death of the high priest (Num. xxxv. 6–34; Josh. xx. 1–9).

Refugees, rĕf'ū-jēs', a name commonly applied to political or religious exiles, but originally and particularly to the French Protestants who fled from their native country on account of the persecutions to which they were exposed after the repeal in 1685 of the Edict of Nantes, under which the reformed doctrines had enjoyed toleration from the year 1598. About 800,000 Protestants fled from their native country. England, Denmark, Holland, Switzerland, Germany, in the latter especially Saxony, Brandenburg, and Hesse, received these fugitives with hospitality. See Huguenots.

Refunders. See Readjusters.

TABLE II.—ACTUAL AND THEORETICAL PERFORMANCE OF ICE-MAKING MACHINES.

(From Paper by Denton and Jacobus, Transactions of American Society of Mechanical Engineers 1892.)

CLASS OF MACHINE	Authority	Number of test	Dimensions of compression cylinder, in inches		Absolute pressure in pounds per sq. inch.		Temperature corresponding to pressure in degrees F.		Temperature of brine in degrees F.		Revolutions per minute	Horse-power of steam cylinder	Per cent of indicated power of steam cylinder lost in friction	Ice-melting effect in tons per 24 hours	Ice-melting effect in pounds per pound of coal, at 3 pounds per hour per horse-power of steam cylinder of compression machine, and an evaporation of 11.1 pounds of water per pound of combustible from and at 212° F. in the absorption machine.		
			Bore	Stroke	Condenser	Suction	Condenser	Suction	Inlet	Outlet					Theoretical no super-heating during aspiration		Actual
															No friction	With friction	
Ammonia cold compression........	Schroter	1	9.9	16.5	135.4	55.3	72.3	26.6	42.8	37.2	44.9	17.9	14.4	26.2	58.67	50.23	40.63
	"	2	9.9	16.5	131.4	41.9	70.5	14.3	28.4	23.0	45.1	18.0	16.7	19.5	45.14	37.59	30.01
	"	3	9.9	16.5	128.0	30.3	69.2	0.5	14.0	8.8	45.1	16.8	16.0	13.3	35.04	29.44	22.03
	"	4	9.9	16.5	126.4	22.2	68.5	—11.8	—0.3	—5.5	44.8	15.5	19.5	9.0	28.29	22.76	16.14
	"	5	9.9	16.5	199.5	41.9	95.5	14.4	28.3	23.0	45.0	24.1	10.5	16.5	29.79	26.68	19.07
	"	6	9.9	16.5	135.8	60.0	72.4	30.2	43.7	37.2	45.2	17.9	10.7	29.8	64.74	57.85	46.29
	"	7	9.9	16.5	131.4	45.1	70.6	17.8	28.3	23.0	45.1	18.0	12.1	21.6	48.40	42.56	33.23
	"	8	9.9	16.5	125.6	23.7	68.2	—9.4	—0.4	—5.8	44.7	15.6	18.0	9.9	29.83	24.46	17.55
	"	9	9.9	16.5	116.9	41.0	64.2	13.1	28.4	23.0	45.0	16.4	13.5	20.0	50.53	43.70	33.77
	"	10	9.9	16.5	130.0	60.3	70.0	30.7	42.8	37.3	31.7	12.0	14.8	19.5	69.40	59.09	45.01
Pictet fluid dry compression........	Schroter	11	11.3	24.4	56.7	20.9	77.3	28.5	43.0	37.5	57.0	21.5	22.9	25.6	55.01	42.48	33.07
	"	12	11.3	24.4	55.6	14.9	76.2	14.4	28.5	23.0	56.8	20.6	22.9	17.9	41.05	31.71	24.11
	"	13	11.3	24.4	54.6	9.7	75.2	—2.5	14.1	8.8	57.1	18.5	24.0	11.6	30.22	23.36	17.47
	"	14	11.3	24.4	60.4	6.7	80.6	—15.9	—0.3	—5.7	57.6	15.7	25.7	5.7	22.28	16.50	10.14
	"	15	11.3	24.4	90.9	14.9	104.4	14.4	28.3	23.0	59.3	27.2	16.9	15.7	25.16	20.88	16.05
	"	16	11.3	24.4	61.0	22.3	81.2	31.5	43.5	37.5	57.3	21.6	14.0	28.1	54.32	46.67	36.19
	"	17	11.3	24.4	59.3	15.6	79.6	16.2	28.4	23.0	57.5	20.5	12.8	19.3	40.13	35.01	26.24
	"	18	11.3	24.4	58.7	6.7	79.1	—15.9	—0.4	—5.6	57.8	15.9	21.1	6.8	22.72	17.90	11.93
	"	19	11.3	24.4	54.3	22.2	74.9	31.3	42.8	37.5	35.3	12.4	22.3	17.0	62.83	49.17	38.04
	"	20	11.3	24.4	88.7	15.6	102.9	16.2	28.3	23.1	42.9	19.9	14.7	11.9	26.78	22.86	16.68
	"	21	11.3	24.4	62.1	6.5	82.2	—16.9	—0.1	—5.3	34.8	9.9	24.3	3.5	21.51	16.30	9.86
Bell Coleman air..................	Schroter	22	28.0	23.8	58.8	14.7	64.8*	—52.6*	....	....	63.2	83.2	21.9	10.3	12.09	7.94	3.42
Closed cycle air..................	Renwick Jacobus	23	10.0	18.0	175	53.7	81.3*	—40.2*	....	....	93.4	38.1	32.1	4.9	14.8	8.1	3.0
Ammonia dry compression.........	Denton	24	12.0	30.0	166	42.7	84.2	15.0	36.8	28.9	58.1	85.0	22.7	73.9	35.91	27.36	24.16
	"	25	12.0	30.0	167	22.9	84.6	—10.8	6.3	2.0	57.7	72.6	18.6	37.9	23.18	18.78	14.58
	"	26	12.0	30.0	162	27.7	82.7	—3.2	14.3	2.3	57.9	73.6	19.3	46.5	26.94	21.56	17.55
	"	27	12.0	30.0	176	42.2	87.7	14.5	36.4	28.5	58.9	88.6	19.7	74.4	33.54	26.94	23.31
Ammonia absorption	Denton	28	....	....	152.3	40.4	79.1	12.6	20.7	15.7	....	....	....	42.2	38.5	....	20.1

* Temperature of air at entrance and exit of expansion cylinder.

Regat'ta, originally a gondola race held annually with great pomp in Venice on the canals intersecting the city. The term is now popularly employed in the United States and other countries to signify a showy sailing or rowing race, in which a number of yachts or boats contend for prizes.

Regelation, rē-jē-lā'shŏn, a phenomenon observed by Faraday in 1850, namely, that two pieces of moist ice placed in contact will freeze together, even in a warm atmosphere. It is proved that beside the pressure from the weight of the upper piece of ice there is atmospheric pressure holding the two pieces together; this pressure melts the ice at the parts which bear on one another, and thus enough heat is absorbed to produce regelation. Professor Thomson's discovery, that the freezing-point is lowered by pressure, explains the motions of glaciers and the apparent plasticity of ice under pressure.

Regenera'tion, the act or the state of being born again in a spiritual sense. The word is a literal version of the term *palingenesia,* peculiar to the New Testament, in which it occurs twice only, namely, Mat. xix. 28, where it signifies the renovation of all things at the second coming of Messiah; and Titus iii. 5, "washing of regeneration," where it signifies a new life, a new spirit in the individual redeemed soul. In many other passages of the New Testament, and specially in John iii. 1–10, the new birth is spoken of without the use of the word regeneration, but in such terms as plainly to indicate that the soul which is received into the kingdom of Christ is born into a new life. Regarding the relation of the sacrament of baptism to the new birth there are chiefly two divergent views entertained by divines. One view, which till the Reformation was well nigh universal, and which is still held by the Catholic Church as an article of faith, regards baptism as the agency whereby the Holy Spirit bestows the new life. According to the other view the washing of water in baptism is but a sensible representation of the spiritual new birth, and regeneration is effected independently of baptism by the direct action of the Holy Spirit. The first view is called that of "baptismal regeneration." Article xxvii. of the Articles of Religion of the Church of England teaches that baptism is "a sign of regeneration whereby, as by an instrument, they that receive baptism are grafted into the Church"; but in 1849, by a judgment of the privy council, it was decided that in the Established Church of England Baptismal Regeneration is not a doctrine taught in her articles and formularies as legally construed.

Regensburg, rā'gĕns-boorg. See RATISBON.

Regent, rē'jĕnt, in a general sense, is a ruler, the ruler of a state; in a more limited sense, one who exercises the highest power vicariously during the absence or incapacity of the lawful sovereign.

Regent is also the title of certain state officers of New York who exercise authority over the higher educational institutions.

Regent-bird, a bird of eastern Australia (*Sericulus chrysocephalus*), allied to the bower-birds, which derives its name from the golden color of the head. The males possess a brilliant plumage of glossy satin-like texture and of black and yellow colors, but the females are dingy in appearance. The regent-birds are of very shy habits, and inhabit the forest depths, making bowers less complicated and striking than those of some other bower-birds (q.v.), but for the same purpose. The food consists of fruits and seeds principally. One of the honey-eaters is called mock regent-bird on account of its black and yellow plumage.

Regent Diamond. See DIAMOND.

Regent's Park, London, England, one of the principal metropolitan pleasure-grounds, covering 470 acres, in the western boroughs of Marylebone and Saint Pancras. The Zoological Gardens are in the northern section of the park, and the Royal Botanic Gardens occupy a circular area in the southern section. See LONDON.

Reggio di Calabria, rĕd'jō dē kä-lä'brē-ä, Italy: (1) capital of a province of same name, a seaport town opposite Messina at the extreme southern point of the peninsula. Reggio was founded by Greek colonists at an early period, becoming later a Roman possession. Ancient Græco-Roman baths were recently revealed in excavating. It fell alternately into the hands of Saracens, Spaniards, and Turks, and finally, in 1783, its ruin was almost completed by earthquake. Its chief industries are the manufacture of essential oils, olive oil, silk, and printing. Pop. about 46,000. (2) The province is rugged and mountainous, covering an area of 1,221 square miles.

Reggio nell' Emilia, nĕl lā-mĕl'lē-ä, Italy, (1) capital of the province of the same name, 38 miles northwest of Bologna, on the canal of Tassone. It is well-built and enterprising. Its chief points of interest are its ancient walls and ramparts, cathedral, and library. Ariosto and Spallanzane (qq.v.) were born in Reggio. Pop. (1901) 59,176. (2) The province lies between Parma on the west and Modena on the east. Its southwest portion is covered by the Apennines. The opposite portion is flat and alluvial, bordering the Po. Area 884 square miles; pop. about 300,000.

Regicide, a term applied to persons who bring about the death of a king, by assassination or otherwise, and specially applied in history to the judges of Charles I., and the members of the French Convention who voted for the death of Louis XVI. Of the judges, 67 in number, who actually sat in trial on Charles I. only 59 signed the death warrant. After the Restoration the regicides were brought to trial on a charge of high treason. Twenty-nine were condemned to death, but only 10 were executed, 19, together with 6 others who were not tried, being imprisoned, most of them for life. More than 20 who were already dead were tried and condemned, notwithstanding, and Cromwell, Ireton, and Bradshaw, three of them, were exhumed and hanged at Tyburn, and then reburied at the foot of the scaffold.

In July 1660, there arrived at Cambridge, Mass., Edward Whalley and his son-in-law, William Goffe, two of the judges who had condemned Charles I. For some months they appeared in public and joined in the devotional meetings in Cambridge and Boston, where they were kindly received. Upon the news of the passage by Parliament of the Indemnity Act marking Whalley and Goffe for vengeance as regicides, they fled to New Haven and were received and concealed by Davenport in the «Judges' Cave.» They were concealed from pursuit at New Haven and Milford for nearly two years. After this they fled to a cave in New Hampshire, but were there discovered by some Indians and returned to Hadley, Mass., where they were concealed until their death, Whalley dying in 1674, Goffe in 1679. When King Philip attacked Hadley in 1675, Goffe appeared and led the defense. Dixwell, another regicide, also escaped to New England.

Regillus, rĕ-jĭl'ŭs, **Lake,** a lake of ancient Latium, lying to the southeast of Rome, noted as the scene of a great victory won by the Romans over the Latins 496 B.C. No certain identity has been established with any modern lake, though some would locate it in the crater of an extinct volcano near the town of Frascati, and others find it in the Lago della Doganella, east of the Alban Mount.

Regiment, one of the divisions of a modern army. Regiments appear to have originated with modern standing armies. They are mentioned in France in 1562, and in England in 1588. The regiment may be considered as the unit of organization of a modern army. The various parts which compose it are never permanently separate, except in the artillery, which is organized in an anomalous way. In the United States each regiment of cavalry consists of 12 troops and 1 band, organized into 3 squadrons of 4 troops each, and under the minimum requirements of the law is constituted as follows:

For each regiment: 1 colonel and 1 lieutenant-colonel, 1 chaplain, and 2 veterinarians. The non-commissioned staff consists of a regimental sergeant-major, 1 quartermaster-sergeant, 1 commissary-sergeant, and 2 color-sergeants. For each troop: 1 captain, 1 first and 1 second lieutenant, the enlisted force consisting of 1 first sergeant, 1 quartermaster-sergeant, 6 sergeants, 6 corporals, 2 cooks, 2 blacksmiths and farrier, 1 saddler, 1 wagoner, 2 trumpeters, and 43 privates. A major commands each squadron, for which a staff consisting of an adjutant (1st lieutenant) and quartermaster and commissary (2d lieutenants) and 1 sergeant-major is authorized.

Each regiment of infantry consists of 12 companies and 1 band, organized into 3 battalions of 4 companies each, and under the minimum requirements of the law is constituted as follows: For each regiment 1 colonel and 1 lieutenant-colonel and 1 chaplain. The non-commissioned force consists of a regimental sergeant-major, and 2 color-sergeants. For each company, 1 captain, 1 first and 1 second lieutenant, the enlisted force consisting of 1 first sergeant, 1 quartermaster-sergeant, 4 sergeants, 6 corporals, 2 cooks, 2 musicians, 1 artificer, and 48 privates. See REGULAR ARMY; ARMY OF THE UNITED STATES; etc.

Regina, Canada. The first seat of government in the Northwest Territories and since 1 Sept. 1905 the capital of the new province of Saskatchewan. Regina has had a degree of progress in recent years quite in harmony with that of the vast country around it. Its area for distribution comprises 60,000 square miles with, in 1912, over 250 towns and villages having a population of 500,000.

Railways and Location.— The main line of the Canadian Pacific Railway bisects the city which is also the southern terminus of the Regina and Prince Albert Railway, which serves fertile districts extending 250 miles to the north. It is the western terminus of the Arcola extension of the Canadian Pacific Railway, traversing a rich and fertile country of which 150 miles is tributary to Regina. So with the line from Sault Ste. Marie and one other branch line. The Canadian Northern Railway has two lines entering the city through the city and the Grand Trunk Pacific has one line passing through the city, two more branches will be in operation during 1912 and three others are projected. Regina is the chief railway centre between Winnipeg and Calgary, a distance of 840 miles — 360 from the former and 480 from the latter.

Industries.— The land in the immediate vicinity of Regina is as good and fertile as that in any part of the continent of America, the soil to the south and north of the railway track being particularly rich. Generally speaking, the characteristic of the land is a black clayey loam three or four feet deep, with a sub-soil of clay. It produces the finest wheat and for vegetables and garden produce the Regina district cannot be surpassed anywhere in the world. The local market gardeners retail their produce to places many miles away. Wheat grown in the district has been selected by the United States authorities for seed-grain, and many portions of the Dominion send to the district for seed in order to improve the wheat they grow. Not only is the quality of the grain good, but the yield is great. According to the official bulletin of the government the average yield per acre of spring wheat in the Regina district during seven years was 20.96 bushels.

As the provincial headquarters of the Massey-Harris Company, the American-Abell Engine and Thresher Company, the International Harvester Company, the Cockshutt Plow Company, and 20 other branch establishments it is the centre of a steadily growing distributing trade. Among the local industries of Regina are grain separators and picklers, office and bank fixtures, sash and doors and builders' materials, pressed brick and artificial stone, pork-packing, cement blocks, marble works, soda water, aerated waters, flour mills, foundry and machine works, planing mills, roofing, furniture, harness manufactures, baking powder, iron works, brick, mattresses, agricultural machinery, tanning mills, and soap works.

Financial and Commercial Progress.— Regina's period of real progress began in 1903. Its assessment in that year was $1,226,000; in 1904 it was $2,284,710; in 1910 it was $15,596,865. The building operations of 1903 are said to have totalled $500,000; in 1909 the total was $749,194, in 1910 $2,351,288, in 1911 $15,031,000. In 1889 the duties paid at the Regina custom house were $2,500; in 1899 they were $18,524; in 1911 they were nearly $300,000. The post-office revenue in 1901 was $9,607, and in 1904 $905,000. The Bank clearings in 1910 were $50,739,159 and in 1911 $72,487,159.

Institutions and Government.— There are six schools in the city as well as a high school and a normal school, and schools are plentiful throughout the district. There are four weekly newspapers and one daily newspaper, an active board of trade, a live agricultural association, 11 branches of chartered banks, two clubs, 10 hotels; while as to merchandise every branch is supplied by large and well stocked stores. The professions too are well represented. The elevator capacity is large there being six elevators and a flour mill in the city, and many in the district. The Church of England, the Roman Catholic, the Presbyterian, the Methodist, the Baptist and Greek Churches, and the Salvation Army, have each a place of worship; temperance and missionary organizations are active throughout the district. The city has also a splendid new hospital with the most modern equipment. It suffered greatly, though temporarily, from a cyclone which destroyed entire streets early in 1912.

The municipal government of the city is entrusted to an elected council consisting of mayor and aldermen. A vigorous policy of municipal ownership and operation of franchises has been inaugurated. The result is that Regina has an up-to-date electric light service and an excellent gravitation water-works system. An equally good drainage and sewage system has been completed and the streets and avenues have been boulevarded.

History and Population.— Regina was started as a prairie village, or settlement, and grew for some years rather slowly. In 1882 it was a village of tents; in 1901 its population was only 2,249; in 1905 the population was estimated at 8,000; the census of 1911 put it at 30,213 while a local census claimed 41,000. Yet for years it had been the centre of government for vast regions, including 345,000,000 acres of land. To-day increasing population and production in the surrounding country have made it the commercial, judicial, scholastic and political centre of the province of Saskatchewan.

J. CASTELL HOPKINS,
Author of 'The Canadian Annual Review.'

Regiomontanus, rē''jĭ-ŏ-mŏn-tā'nŭs, German astronomer, whose real name was Johann Müller, but who assumed that of Regiomontanus, in allusion to the place of his birth, Königsberg (Kings Mountain), Franconia: b. 6 June 1436; d. Rome 6 July 1476. Having received a classical education at Leipsic he placed himself under Purmachius (Georg von Purbach), the professor of mathematics at Vienna, and under him became one of the first astronomers of that age. With Purbachius he accompanied Cardinal Bessarion to Rome in 1461, where Beza gave him further instruction in Greek literature, and he now completed a new abridgment in Latin of the 'Almagest' of Ptolemy (1496), correcting many errors in the former translation, made by George of Trebizond. In 1471 he built an observatory at Nuremberg and established a press; but after three years returned to Rome on the invitation of Sixtus IV., who employed him in the reformation of the calendar, and rewarded his services by raising him to the bishopric of Ratisbon (1475). He died, according to some, of the plague, according to others by poison administered by the son of George of Trebizond, out of revenge for his having exposed the errors of his father. Regiomontanus was the first in Germany to apply himself to the cultivation of the neglected science of algebra. He made great improvements in trigonometry, into which he introduced the use of tangents. His refutation of a supposed discovery of the quadrature of the circle, and numerous writings on various subjects of natural philosophy, display extensive learning and great acuteness. His astronomical observations from 1475 to 1506 ('Ephemerides') are very accurate. Among his other works 'Kalendarium' (about 1474), 'De Triangulis Omnimodis' (1533); 'Tabulæ Directionum Prejectionumque in Nativitatibus multum utiles' (1585). Consult Gunther, 'Johannes Müller' (in the 'Allgemeine deutsche Biographie,' Vol. XXII., 1855).

Register, the title of a public officer who has charge of records, his duties varying in different States. Also a device for automatically indicating the number of revolutions made or amount of work done by machinery; or recording steam, air, or water pressure, or other data, by means of apparatus deriving motion from the object or objects whose force, distance, velocity, direction, elevation, or numerical amount it is desired to ascertain. There are various appliances of this kind, each particularly adapted for the peculiar operation which is to be investigated; many depending on the action of clockwork mechanism, which indicates results on dials, but others, as in registering meteorological instruments, having means for recording varying conditions, as with the anemometer, barograph, etc. The cash register is a machine tor recording money payments. It is of very general use in retail establishments throughout the world.

Registration of Births, Marriages, and Deaths. France has the most perfect system of registering births, marriages, and deaths. There it is the duty wholly of the civil authority, and the methods are so thorough and comprehensive that it is practically impossible for a birth, a marriage or death to occur without going on record. In the United States registration of births, marriages, and deaths is universally required by State laws, but it is only in well organized municipalities that it is fully enforced, and even there much depends on the willingness of doctor, minister, or other civilian upon whom the law imposes the duty of making report to the authorities, to perform that duty. In rural and remote districts births, marriages and deaths often go unrecorded, thus causing doubt and uncertainty which may cast a cloud on property titles and the legitimacy of children. Claims to great age are often made more than doubtful by the lack of any authentic evidence as to date of birth. Indeed, owing to the lax methods of registration which prevailed up to the latter part of the 19th century it is almost impossible to establish the pretensions of alleged centenarians. The importance of registration has of late, however, impressed itself deeply on the public, and everywhere throughout the United States an improvement is being witnessed in this regard.

Registration of Property Titles. The United States leads the world in its system — which is practically the same everywhere throughout the Union — of recording property transfers. The possession of a deed of property is not proof of title. The title rests legally in the person in whose name it is recorded in the books of the register or recorder, or by whatsoever name the official having charge of such records is known. The first business therefore of a person acquiring property is to have the deed registered. Otherwise the former owner could sell the same property to another, and if the latter had received no notice of the previous transfer, the transaction, and gave value for the estate, and had his deed recorded first, he could hold the property against the person who had received a previous deed, but had failed to put it on record. The officials in charge of the records are sometimes county and sometimes town officers, and the deed is recorded the moment it is received, even although not entered on the books for some time after. Therefore it is carefully stamped with the hour, minute and even second of its presentation. The old cumbersome English method of vesting title on a trunkful of deeds is therefore unknown in America, where registration has been the rule from the time of the earliest settlers, who allotted lands to each freeman, and made a record of the division.

Chattel mortgages are also recorded; otherwise the mortgagee is without protection against transfer to a third and innocent party who might purchase the goods, or advance money on them.

England has been slow to follow the example of the United States in this as in other matters, but the convenience of the American system and the cumbersomeness of the English, which was growing more top-heavy year by year, has led to the adoption of a method of voluntary registration which makes it possible to transfer and hold property without having to hand over or keep a mass of old title-deeds. In Scotland an excellent system for the registration of transfers of heritable property has existed since 1617.

Registration of Voters. Registration of voters is required by law in most of the American States, as a check to fraudulent voting. In some States a voter having once registered is not required to register again while he retains the same qualifications and residence. In the State of New York yearly registration is required in the large cities, while in the country districts it is not necessary. Previous to registration «repeating» — that is voting more than once in one election — and other frauds were very common, and probably affected the results of important political contests. The voter is required, as a rule, to give his name, age, residence, place of birth, and if of foreign birth, produce his naturalization papers, should the registering officials demand them. For a short time New York State had a law requiring the registry board to make a record of the physical defects of voters for identification, but this proved offensive and unpopular, and was soon repealed. It is a penal offense to make a false statement in registering. See various articles dealing with voting and suffrage.

In Great Britain and on the continent of Europe, voters are required to register, a most exact scrutiny being enforced as to the possession of legal qualifications for the suffrage.

In England the registration of electors was first established by the Reform Act of 1832, in terms of which, in England, the overseers of each parish were required to draw up a register of all persons qualified to vote. This still forms the basis of procedure, but the law has been frequently altered, the latest act on the subject being the Registration Act of 1885.

Regium Donum, rē'jĭ-ŭm dō'nŭm («royal gift»), an annual grant of public money formerly received by the Presbyterian and other Non-conformist ministers in England, Scotland, and Ireland. The Irish Regium Donum was withdrawn by the Act of 1869, which came into force in 1871, disendowing the Irish Episcopal Church. Compensation was made of life interests; and the ministers were allowed to commute on the same terms as the clergy of the Church. In 1874 it was reported that the commutation money paid had amounted to $2,898,810. The Regium Donum in England was enjoyed by the three denominations, Presbyterians, Independents, and Baptists, from 1723 till 1851. The amount required was annually voted by Parliament till 17 July 1857. The Scotch Episcopalians also enjoyed for a time a small share.

Regius (rē'jĭ-ŭs) **Professors,** the designation of professors at Oxford and Cambridge whose chairs were founded by Henry VIII. The name is also given to professors in other universities who receive their appointments from the crown.

Regla, räg'lä, Cuba, town, province of La Habana, on Havana Harbor opposite the city of Havana. It is connected with Havana by ferry, with Matanzas and other towns to the east by rail and also has a street railway running to Guanabacao. It contains foundries, shipyards, and large sugar warehouses, and has a considerable trade, especially in the exporting of sugar. It contains a large bull ring, formerly the scene of the Havana bull fights. Pop. about 14,000.

Regnard, rĕ-năr, **Jean François,** French comic dramatist: b. Paris 1 Feb. 1655; d. Grillon 4 Sept. 1709. He was the son of a rich merchant, and while on a voyage to Italy was captured by pirates and sold as a slave in Algiers. Being redeemed by his family he traveled extensively in Holland, Germany, Poland, and Lapland. He wrote many comedies for the French stage, his masterpiece being 'Le Joueur' (1696), which holds a place second only to some of Molière's. Other pieces produced at the Théâtre-Française were: 'La Sérénade' (1694); 'Le Bourgeois de Falaise' (1696); 'Le Distrait' (1697); 'Democrite' (1700); 'Le Retour imprévu' (1700); 'Les Folies amoureuses' (1704); 'Les Ménechms' (1705). The best editions of his works are by Didot (1820); Michiels (1854); Fournier (1875); Moland (1893).

Regnault, rĕ-nō, **Alexandre Georges Henri,** French painter: b. Paris 30 Oct. 1843; d. Buzenval 19 Jan. 1871. He was trained in art under Lamothe and Cabanel; in 1866 carried off the Prize of Rome by his 'Thetis Bringing Weapons to Achilles' and for the next two years lived in Italy, where he furnished illustrations to the 'Travels' of Francis Weh. He next visited Spain where his passion for light and color was satisfied in studying the works of Goya and Velasquez, of whose 'Las Lanzas' he made a copy. In fact, his first work of importance, a colossal equestrian portrait of General Prim (now in the Louvre) was executed at Madrid. He had a natural, temperamental preference for the features of oriental life, and he loved to paint incidents and scenes of horror. Of such a character is his 'Salome,' a personification of bloodthirsty passion; and 'Decapitation in Granada'; two canvases of marvelous daring in color, but repulsive from their cold brutality. When the war of 1870 broke out he returned to France, enlisted, and was killed at the battle of Buzenval, near Paris. The circumstances of his death have invested his name with a certain halo of glory in the eyes of his countrymen and have tended to impart an exaggerated importance to his artistic achievements. Consult: Cazalis, 'Henri Regnault, sa Vie et son Œuvre' (1872).

Regnault, Henri Victor, French chemist and physicist: b. Aix-la-Chapelle, Germany, 21 July 1810; d. Auteuil, France, 19 Jan. 1878. After study at the Ecole Polytechnique of Paris, he became a mining engineer and later a professor at Lyons. His 'L'Action du Chlore sur l'Ether Chlorhydrique' (1840) won for him a professorship at the Ecole and admission to the Academy of Sciences. In 1841 he was made professor of physics in the Collège de France, in 1847 chief mining engineer, and in 1854 director of the Sèvres porcelain manufactory. Among his writings, besides many scientific papers in learned journals, are: 'Cours Elémentaire de Chimie' (1849–50; 6th ed. 1870); and 'Premiers Eléments de Chimie' (1850; 6th ed. 1874).

Regnault, Jean Baptiste, French painter: b. Paris 19 Oct. 1754; d. there 12 Nov. 1829. He studied under Bardin and after capturing the Prix de Rome in 1776, entered the Academy in 1783 and became eventually a professor in the Ecole des Beaux Arts (1755). The influence of David was predominant in his day, and Regnault's paintings are all in the conventionally classic manner of that master. Many of his works are in the Louvre, among them his 'Baptism of Christ,' and his most notable picture, the 'Education of Achilles.' He also produced the historically interesting works, 'The Acceptance of the Constitution by Louis XVI.'; 'Napoleon Proclaimed Consul for Life'; 'Battle of Marengo'; and 'The Death of Dessaix.'

Régnier, rā-nē-ā, Henri François Joseph de, French poet: b. Honfleur 28 Dec. 1864. He was numbered in his earlier days among the Parnassians and later was allied with Mallarmé and the symbolists. His admirers are found among the younger literary men rather than among the academic. Critics have found his verse excellent for a delicacy of taste and a kind of antique inspiration, but have blamed him for sacrificing too much of the sentiment or the idea to the last refinement of expression. He has published in verse 'Sites' (1887); 'Poèmes ancièns, romanesques' (1890); 'Tel qu'en songe' (1892); 'Les Jeux rustiques et divins' (1897); 'Les Médailles d'Argile' (1900); etc., and the novels 'La Cânne de Jaspe' (1895); 'Le Trèfle blanc' (1899); 'La double Maîtresse' (1900).

Regnier, Mathurin, French satirist: b. Chartres 21 Dec. 1573; d. Rouen 22 Oct. 1613. He was a nephew of the poet Desportes; served as secretary in Rome to the ambassadors Joyeuse and Béthune. Having taken orders as a youth he was granted a canonry at Rouen upon his return from Rome, but his dissipated habits shortened his life. He was famous for his satires in imitation of Horace, Juvenal and Martial, especially those in which he attacked Malherbe, the reigning literary authority of his day. He showed knowledge of life and character and a power in the expression of manners that in the opinion of Sainte-Beuve ranked him after Montaigne, Ronsard, and Rabelais. No good edition of his works appeared in his lifetime; that published in 1608 and in 1613 was entitled, 'Satires et autres Poésies de Maturin Régnier.' The principal modern editions are those by Viollet-le-Duc (1822); Barthélemy (1862); Courbet (1869 and 1875).

Regular Army. The United States Army, as at present constituted, is organized under the Act of Congress, 2 Feb. 1901. It consists of 15 regiments of cavalry, an artillery corps, 30 batteries of field artillery and 126 batteries of coast artillery, 30 regiments of infantry, 3 battalions of engineers, and an additional provisional force of more than 5,000 men. The total strength of the army is about 66,000 men of whom 3,820 are commissioned officers. The act of 1901 provides that the army shall at no time exceed 100,000 men. The general staff of the army includes one lieutenant-general, Samuel B. M. Young, chief of staff; one major-general, Adna R. Chaffee, two brigadier-generals, three colonels, five lieutenant-colonels, and a number of majors and captains. The army is at present largely employed in keeping order in the Philippines, which constitute a military division, divided into the three departments of Luzon, the Visayas and Mindanao.

At the beginning of the war with Spain in 1898 the United States army numbered only about 26,000 men. Energetic measures, supported by voluntary enlistments in every part of the Union, raised this force at one time to 275,000 men. The war was followed by insurrections in the Philippines, and it was deemed best not to make a sweeping reduction of the regular forces, but to leave such reduction largely to the discretion of the President, who would be guided by events as they should arise in increasing or decreasing the number of men under arms. The bill which became a law made it discretionary with the President, under certain conditions, to increase or decrease the army between fixed limits — a maximum of 100,000 men and a minimum of 60,000, the latter being the peace footing of the organization.

In 1903 a bill was passed providing for a general staff, intended to bind the several branches of the service into one organism, with responsibility concentrated in one officer — the chief of staff. The chief of staff takes the place of the general commanding the army. The President, as commander-in-chief, gives the orders, the chief of staff sees that they are carried out; and in case of war the general staff becomes a war board, the board of strategy to plan and direct campaigns, and is answerable for success or failure of its plans, provided officers and the field do their duty. Under the chief of staff is a group of officers selected from the line and staff of all branches of the service, whose duty it is to keep the chief informed in all details of their several departments.

A new militia law was likewise passed in 1903. It provides for the more complete equipment of this section of the service and the establishment of better co-operation between the National Guard and the Regular Army, and it aims at the creation of a National Volunteer reserve. The present strength of the militia is about 109,000 enlisted men and 9,000 officers.

All persons enlisting in the United States army must be not less than 18 nor more than 35 years of age. They must also be of good moral character, temperate habits, able-bodied and free from disease, and able to speak, read and write the English language. Persons under 18, but meeting the other requirements of the service, are accepted for enlistment if they can produce the written consent of parent or guardian. The height and weight requirements are as follows: For infantry and coast artillery, height not less than five feet four inches; weight not less than 120 and not more than 190 pounds. For cavalry and field artillery service the height must be over five feet four inches and under five feet ten inches, and the weight must not be more than 165 pounds. See ARMY, UNITED STATES; MILITARY ACADEMY, UNITED STATES.

Regular Canons of the Immaculate Conception. See ORDERS, RELIGIOUS.

Regular Clerks of the Faith of Jesus. See ORDERS, RELIGIOUS, *Baccanarists*.

Regulars, in the Roman Catholic Church, persons of either sex who are members of any of the religious orders, congregations, or institutes approved by the Holy See. Those of their number who are in holy orders constitute the Regular Clergy, that is, clergy under a religious rule (*regula*), who are bound by the usual three monastic vows: so contradistinguished from the secular clergy — those clergymen who do not belong to such orders or congregations.

Regulators, a name adopted in South Carolina, about ten years before the Revolution, by citizens who organized themselves to put down lawlessness and enforce respect for life and property. Their methods were very like those of the vigilance committees of California and Nevada, about a century later. The Regulators were pacified by the establishment of courts of law in the disturbed districts.

Some years later in North Carolina an organization calling themselves «Regulators» was formed to resist the extortion and oppression practised by officers of the colonial government. They drove out the local authorities, and Governor Tryon led a military force against them, defeating them after a sanguinary battle, near the Allemance Creek, 16 May 1771. Tryon hanged six of the Regulators for treason. The survivors generally took the patriot side in the War for Independence, and the «Regulator» movement in North Carolina is regarded by some as one of the beginnings of that struggle.

Regulus, rĕg'ū-lŭs, **Marcus Atilius,** Roman general of the 3d century B.C. He was made consul in 267 B.C., and a second time about 256 B.C. With his colleague, Manlius Vulso, he commanded in the first war against Carthage. With a fleet of 330 ships carrying 40,000 men the consuls defeated a superior Carthaginian fleet in the battle of Ecnomus and effected a landing in Africa. Here Regulus followed up his victories so successfully that in a short time he presented himself before the capital of the enemy. Carthage sued for peace and Regulus who wished to end the war before his successor was appointed demanded unconditional submission. The Carthaginians refusing the terms ended the negotiations and at this juncture were joined by a small body of Spartan volunteers under Xanthippus, to whom was given the command of the Carthaginian forces. In a battle under the walls of Carthage 30,000 Romans fell, and Regulus was made prisoner 255. He remained in Carthage till 250, when the Carthaginians, having been defeated at Panormus were desirous of peace. An embassy was therefore sent to Rome, accompanied by Regulus, who was obliged to bind himself by an oath to return to Carthage if Rome should refuse the terms proposed. Regulus, however, advised the continuance of the war and recommended the Romans not to exchange prisoners. Thereupon he declined to listen to the entreaties of his family or of the senate and persisted in his intention to return to Carthage. It is related that he was put to death with great cruelty, and that Hamilcar and Boscar, two noble Carthaginian prisoners, were given up to the family of Regulus, who took revenge on them in a similar manner. Neither the story of the embassy nor of the revenge is related by Polybius, and Ihne, the German historian, inclines to the modern view that the story was invented to excuse the cruelty of the family of Regulus to their prisoners.

Regulus, the star Alpha Leonis, the brightest in the constellation of the Lion.

Re'gur, a dark superficial soil of India, loam or clayey, occurring chiefly on the tableland of the Deccan and in Nagpur, less frequently in Mysore, and reappearing in southern India in continuous sheets from 6 to 20 feet thick. Although generally a surface soil, it dips beneath recent alluvium. It is extremely fertile, having produced heavy crops for many centuries without requiring manure. Its exact age is undetermined. The name is native.

Rehan, rē'an, **Ada** (originally CREHAN), American actress: b. Limerick, Ireland, 22 April 1860. She came to this country as a child and made her first appearance on the stage at 14 in Newark, N. J. She had not at that time, however, taken up acting as a profession, but continued her education in Brooklyn where her parents lived. She appeared for two seasons at Mrs. John Drew's theatre in Philadelphia, and later in stock companies in Baltimore, Albany and Louisville. In 1879 she became a member of Augustine Daly's stock company first as leading lady and afterward as star, where she continued until Daly's death in 1899. Here she took part in many revivals of old comedy, together with a fewer number of modern plays, principally adaptations from the German made by Daly. Her greatest successes were Katharine in ‹Taming of the Shrew,› and Lady Teazle in ‹School for Scandal,› though she played with acceptance Viola, Portia, Rosalind, and Beatrice, Peggy Shrift in ‹The Country Girl,› and Agatha Posket in Pinero's ‹The Magistrate.›

Since 1899 she has appeared on the stage only at considerable intervals.

Reich, rīh, **Jacques,** American artist: b. in Hungary 10 Aug. 1852. He studied art in Budapest; came to the United States in 1873; continued his art education in New York and Philadelphia; and afterward studied in Paris. He returned to Philadelphia, and became skilled in pen-and-ink drawings and in the etching of portraits on copper. In 1885 he removed to New York. He drew the greater number of the pen-portraits for Scribner's 'Cyclopædia of Painters and Paintings,' and also for Appleton's 'Cyclopædia of American Biography.' His other important work includes a series of portraits of American and English authors and other prominent persons, and half life-size plates of Washington (after the Gilbert Stuart unfinished painting), Jefferson (after the painting by Rembrandt), and President Roosevelt.

Reicha, rī'hä, **Anton Joseph,** Austrian composer: b. Prague, Austria, 27 Feb. 1770; d. Paris, France, 28 May 1836. He made a study of the violin, pianoforte, and flute, and in 1788 he entered the chapel of Maximilian of Austria as second flute. His ambition, however, was to become a composer and after overcoming many difficulties he succeeded in having his symphonies and other compositions played by his uncle's orchestra at the court of the Elector of Cologne. Reicha lived in Hamburg 1794–9 and there wrote his first opera, 'Obaldi, ou les Français en Egypte,' but failed to obtain its production in Hamburg or Paris, though several of his symphonies were well received. In 1802–8 he lived in Vienna, where he enjoyed the patronage of Maria Theresa and was intimate with Beethoven, Haydn, and other great musicians. He removed to Paris in 1808, became professor at the Conservatoire in 1818, was naturalized in 1829, and elected to the Institute in 1835. He was chiefly notable for his chamber music and his theoretical work, though his symphonies and overtures met with considerable success. His operas were lacking in dramatic effect, though their music is excellent. He was also author of numerous theoretical works, among which may be mentioned: 'Traité de Melodie' (1814); 'Traité de haute Composition musicale' (1818); 'Art du Compositeur dramatique' (1833); etc.

Reichardt, rī'härt, **Johann Friedrich,** German composer and author: b. Königsberg 25 Nov. 1752; d. Giebichenstein 17 June 1814. He studied in the universities of Königsberg and Leipsic; was appointed Kapellmeister by Frederick the Great, and during his tenure of office introduced Concerts Spirituels for the performance of novelties with analytical programs. He conducted Italian opera under Friedrich Wilhelm II., but his French sympathies brought about his dismissal in 1794. He was court director at Cassel for a short time during the incumbency of the king of Westphalia. He holds an important place in the history of music from the fact that his Singspiele are factors in the development of German opera, and his Lieder are among the earliest of their kind. He wrote operas, oratorios, and cantatas, besides compositions for orchestra and pianoforte, and set to music Bürger's translation of Macbeth, Goethe's Faust, Egmont, and Tasso, besides many lyrics. He edited musical periodicals and published familiar letters describing his travels ('Vertraute Briefe,' 1810).

Reichenbach, rī'hĕn-bäh, **Karl,** Baron von, German naturalist: b. Stuttgart 12 Feb. 1788; d. Leipsic 19 Jan. 1869. He studied at Tübingen, where he obtained the degree of doctor of philosophy, and was denounced to the Napoleonic police and imprisoned for having organized an association with the fanciful object of founding a German kingdom in the South Seas. He visited the principal iron works in France and Germany, and established others of his own at Villingen, and the first large German charcoal-burning establishment at Hausach in Baden. In 1821 he founded with Count Hugo zu Salm, a number of industrial establishments in Moravia, from which he realized a considerable fortune. The king of Würtemberg raised him to the dignity of baron in 1839. In 1834 he published in Vienna 'Mittheilungen aus Mähren,' the first geological monograph in Austria. He is also credited with some chemical discoveries, in particular of paraffin and creosote. In the course of his studies of animal magnetism he believed he had discovered a new force, which he called *od* and upon which he published several works, as 'Odisch-magnetische Briefe' (1852); 'Der sensitive Mensch and sein Verhalten zum Ode' (1854). Od, he said, was a peculiar power possessed by certain persons of special sensitiveness, which enabled them to detect veins of ore, distinguish negative and positive magnetic poles, start a pendulum without touching it, and the like. He derived the word from the Latin *vado,* "I go quickly." Part of the scientific world attacked his theory, but the larger portion laughed it out of court; and after his death it was quite forgotten. Reichenbach's latest works were 'Köhlerglaube' and 'Afterwissenschaft,' in reply to Karl Vogt (1856); 'Aphorismen über Sensibilität und Od (1866); 'Die odische Lohe' (1867).

Reichenbach, Saxony, 11 miles southwest of and in the circle of Zwickau, is a manufacturing town, trading considerably in woolen and cotton goods. This is the home of the distinguished antiquary, Böttiger (q.v.). Pop. about 26,000.

Reichenberg, rī'hĕn-bĕrg, Austria, town in Bohemia; on the Neisse; about 60 miles in direct line north-northeast of Prague (q.v.). It is a well-built town with several modern public buildings and a number of historic edifices dating back to the 13th and 14th centuries. It is one of the leading manufacturing towns of Austria. The chief manufactures are woolen, cotton, and linen goods, carpets, leather, shoes, hats, gold, and silver ware, musical instruments, and firearms. The schools rank high; it has an excellent industrial school.

Reichmann, rīh'măn, **Theodor,** German opera singer: b. Rostock, Mecklenburg, 18 March 1849; d. Vienna, Austria, 23 May 1903. He studied at Berlin, Prague, and Milan, and became widely known on the German operatic stage as a dramatic baritone. In 1882 he began his engagement at the Vienna Opera House, and in that year created the part of Amfortas in 'Parsifal' at Baireuth. He continued at the Vienna Opera House with great success until 1889, when he came to New York and made his first appearance at the Metropolitan Opera

House in 'The Flying Dutchman.' His reception there was most flattering, and his success was marked throughout his engagements there in 1889–90, 1890–1. He possessed a remarkable voice; and his dramatic impersonation of his various roles made him one of the most famous operatic singers of his day. He was notable in his presentation of the roles: William Tell, Wolfram, Wotan (in 'Siegfried'), Nelusko (in 'L'Africaine'), etc.

Reichsrath, rīhs'rät, the representative council of the empire of Austria. See Austria.

Reichstadt, rīh'stät, **Duke of** (Napoleon François Charles Joseph Bonaparte), titular emperor of France: b. Paris 20 March 1811; d. Schönbrunn, Austria, 22 July 1832. He was son of Emperor Napoleon I. (q.v.), and from his birth was styled «king of Rome.» After his father's first abdication in 1814 he went with his mother to Vienna. After Waterloo, Napoleon proclaimed him Napoleon II. (22 June 1815). He was brought up at the court of his grandfather, the Emperor Francis, who created him Duke of Reichstadt (1818). His education was careful, and he was early trained to the military profession. After passing through subordinate grades he was made a lieutenant-colonel in June 1831, and took command of a battalion in the Gyulai regiment of Hungarian infantry, then garrisoned at Vienna. He was extremely attentive to his military duties, but he had grown very tall and slender, and symptoms of consumption had early shown themselves. His physician advised a removal to Schönbrunn, but this proved unavailing. The Duke is said to have possessed rare linguistic powers. He was made the hero of 'L'Aiglon' ('The Eaglet'), a drama by Edmond Rostand (q.v.). Upon the accession of Napoleon III. (q.v.), he was reckoned among French sovereigns as Napoleon II. Consult: Welschinger, 'Le Roi de Rome' (1879); Lacroix, 'Le Roi de Rome' (1899); Wertheimer, 'Der Herzog von Rom' (1902).

Reichstag, rīhs'täg, the representative legislative body of the German nation as a whole. The Bundesrath is of the separate German states. The president of the Reichstag is elected by the deputies. See Germany.

Reid, rēd, Sir **George,** Scottish artist: b. Aberdeen, Scotland, 31 Oct. 1841. He studied art in Edinburgh, Utrecht, Paris, and The Hague, being the pupil in turn of Mollinger, Israels, and Yvon. In 1891 he was elected president, in succession to Douglas, of the Royal Scottish Academy. He is widely known for his fine portraits. He is also distinguished as a flower and landscape painter and is a book illustrator of no mean merit.

Reid, George Agnew, Canadian painter: b. near Wingham, Ontario, 1861. At Paris he was a pupil of Constant, Lefebvre, and Dagnan-Bouveret and became a constant exhibitor at the Salon. The World's Fair Columbian medal was awarded to his 'The Foreclosure of the Mortgage' (1893). He has been successful in panel decoration and the series in the entrance hall of the Municipal Buildings, Toronto, contain very good examples of his style. In 1898 he was elected president of the Ontario Society of Artists.

Reid (Thomas), Mayne, British author of tales of adventure: b. Ballyroney, County Down, Ireland, 4 April 1818; d. near Ross, Herefordshire, England, 22 Oct. 1883. The son of a Presbyterian minister he was educated for the ministry, but love of adventure took him to this country, where he engaged in various callings, and traveled widely as hunter and trader. In 1843 he was a journalist in Philadelphia, but joined the United States army as a volunteer in 1846 and fought in the Mexican War, his experiences in which furnished him with materials utilized in several novels. He afterward went to London and became well known as a writer of thrilling stories, many of them based on his American experiences, such as 'The Rifle Rangers'; 'Scalp Hunters'; 'The War Trail'; 'The Headless Horseman'; etc. He returned to America in 1867 and founded the 'Onward Magazine,' which was unsuccessful, and in 1870 went back to England. Many of his tales were translated into French and German. They were all very readable and healthy in tone, though extravagant in incident. Consult 'Memoir' by his wife (1890).

Reid, Robert, American painter: b. Stockbridge, Mass., 1863. His work shows the influence of Impressionalism, but as the pupil of Boulanger and Lefebvre in Paris, where he began his art studies, he maintains an academic correctness, and insistence upon detail which render his work singularly effective. His great decorative piece in the Paris Exposition of 1900 ('America Unveiling Her Natural Strength') was much admired, and like all his productions in this department has extended his reputation.

Reid, Robert Gillespie, a Newfoundland railway contractor: b. Coupar-Angus, Scotland, about 1840; d. Montreal, Canada, 3 June 1908. In 1865 he went to Australia, where he took part in gold-mining and public works; in 1871 came to America, and constructed many railways in the United States and Canada. The heaviest section of the Canadian Pacific was built by him; and he was prominent also in bridge-work, constructing the international railway bridge over the Rio Grande, the international bridge across the Niagara, and (1886) the Lachine bridge, over the Saint Lawrence. In 1893 he made with the colony of Newfoundland a contract whereby he was to build a railway from Saint John's to Port-au-Basque to be completed in three years at $15,600 per mile. For the further consideration of a land-grant of 5,000 acres per mile of construction, he was to maintain and operate the railway for 10 years. He contracted with the colonial government in 1898 to operate all the railways of the island for 50 years, maintaining them in a safe and efficient manner, on condition that the railways should become his property at the end of that period. He was to obtain also 2,500,000 acres of land-concessions additional, and the government land telegraph lines. On his part he contracted also to build and operate seven steamers transporting passengers and goods at various points in the island; to buy and operate the Saint John's dry-dock; to build and operate an electric street-railway in Saint John's; to pave a specified portion of Saint John's; and to pay $1,000,000 within one year from the date of the signing of the contract. In fact, he became the real owner of the island, and was popularly known as «Czar» Reid.

Sir Robert Bond, the Liberal leader, protested against the contract, and Reid was finally obliged to transfer his property to the Reid Newfoundland Company, while adjustment of the contract was made favorable to the government.

Reid, Samuel Chester, American naval officer: b. Norwich, Conn., 25 Aug. 1783; d. New York 28 Jan. 1861. He entered the United States navy as a midshipman when very young, rose rapidly in rank and in the War of 1812 commanded the privateer General Armstrong. He repulsed the British attack in the harbor of Fayal, Azore Islands, 26 Sept. 1814, the enemy having three vessels with 2,000 men to his single vessel with 90 men. During 10 hours' fighting, the British lost 300 killed and wounded and the Americans two killed and seven wounded. Reid was subsequently harbormaster and warden of the port of New York. He invented a signal telegraph, reorganized the pilot-boat system, established a lightship off Sandy Hook, and designed the present flag of the United States, first used in 1818, suggesting the retention of the original 13 stripes and the addition of a star for each new State.

Reid, Thomas, Scottish metaphysician: b. Strachan, Kincardineshire, 26 April 1710; d. Glasgow 7 Oct. 1796. He was graduated at Marischal College, Aberdeen, in 1726, and in 1736 presented to the neighboring living of New Machar. It was his custom to preach the sermons of Tillotson and Evans rather than his own compositions, for he was already chiefly absorbed in the study of metaphysics. In 1748 he published a paper in the London ‹Philosophical Transactions,› in which he opposed the introduction of mathematical formulas into metaphysical and moral speculations, and particularly criticized the statement of Hutcheson that the benevolence or moral merit of an agent is «proportional to a fraction having the moment of good for the numerator, and the ability of the agent for the denominator.» He was elected in 1752 professor of philosophy in King's College, his department comprehending logic, ethics, mathematics, and physics. His ‹Inquiry into the Human Mind on the Principles of Common Sense› (1764) aimed at the refutation of Hume's skeptical theory. Affirming the impossibility of proving the existence of an external world from reason, or experience, or instruction, or habit, or any other principle hitherto known to philosophers, Reid introduced the doctrine of an original instinct or «common sense» (q.v.) as the ground of the belief. In 1764 he was transferred to the University of Glasgow as successor of Adam Smith in the chair of moral philosophy. His course included metaphysics, moral philosophy, natural law, and political right. He was a member of a philosophical society before which he read several essays, including an ‹Examination of Dr. Priestley's Opinion Concerning Matter and Mind,› ‹Observations on the Utopia of Sir Thomas More,› and ‹Physiological Reflections on Muscular Motion.› In 1781 he withdrew from public duties to devote himself exclusively to philosophical studies. In 1785 he published ‹Essays on the Intellectual Powers of Man,› consisting of his academical lectures, and in 1788 his ‹Essays on the Active Powers of Man,› his last important work. An edition of his works with notes and dissertations was prepared by Sir William Hamilton (incomplete, 1846). Consult: Ferries, ‹Reid and the Philosophy of Common Sense› (1866).

Reid, Sir **Thomas Wemyss,** English journalist: b. Newcastle-on-Tyne 1842; d. London 26 Feb. 1905. He contributed frequently to English reviews and magazines, edited the Leeds ‹Mercury› (1870–1887), and ‹The Speaker› from 1890 to 1899, when he resigned and published: ‹Cabinet Portraits: Sketches of Leading Statesmen of Both Parties› (1872); ‹Charlotte Brontë: A Monograph› (1877); ‹The Land of the Bey› (1882); ‹Mauleverer's Millions› (1885); ‹Life of William Edward Forster› (1888); ‹Life of Lord Playfair› (1899); ‹Life of W. E. Gladstone› (1899); ‹William Black: a Biography› (1902); etc.

Reid, Whitelaw, American journalist: b. Xenia, Ohio, 27 Oct. 1837. He was graduated from Miami University in 1856; and began his journalistic career as editor of the Xenia *News,* in 1858–9. In 1860 he became a reporter for the Cincinnati *Gazette,* in 1861–2 was war correspondent, and later Washington correspondent for the same paper, the brilliancy and accuracy of his war reports attracting considerable attention among newspaper men. He was aide-de-camp on the staff of Gen. Morris and Gen. Rosecrans in West Virginia. In 1863–6 he was librarian of the House of Representatives and after the war spent some time on a cotton plantation in Concordia Parish, La. In 1868 he joined the editorial staff of the New York *Tribune;* in 1869 became managing editor; and in 1872 editor-in-chief. Under his management the *Tribune* has come to rank among the leading papers of the city in the trustworthiness of its news reports. He twice declined an appointment as minister to Germany, was minister to France in 1889–92 and negotiated important reciprocity treaties, and in 1892 was the unsuccessful Republican candidate for Vice-President. He was the special ambassador from the United States to Queen Victoria's jubilee in 1897; was a member of the American-Spanish peace commission in Paris in 1898; and was special ambassador at the coronation of Edward VII. in 1902. In April 1905 he was appointed ambassador to the Court of Saint James, to succeed Joseph H. Choate. He has been a regent of the University of New York since 1878. He has written: ‹After the War, a Southern Tour› (1867); ‹Ohio in the War› (1868), an important contribution to the local history of the State; ‹Schools of Journalism› (1870); ‹The Scholar in Politics› (1873); ‹Newspaper Tendencies› (1874); ‹Town Hall Suggestions› (1881); ‹Two Speeches at the Queen's Jubilee› (1897); ‹Some Consequences of the Late Treaty of Paris› (1899); ‹Our New Duties› (1899); ‹A Continental Union› (1900); ‹Our New Interests› (1900); and ‹Problems of Expansion› (1900).

Reid, Sir **William,** Scottish meteorologist and colonial governor: b. Kinglassie, Fifeshire, 1791; d. London 21 Oct. 1858. He was educated at the Royal Academy at Woolwich, and in 1809 entered the army as lieutenant of engineers, serving in the Peninsular campaign under Wellington, in America in the War of 1812, and in Belgium in 1815. He was appointed governor of Bermuda in 1838 and by his excellent administration of affairs greatly improved the deplorable agricultural condition of the island. He opened a market for their products in New York and by these and other efficient methods gained the title of "the good governor." In 1846 he became governor of the Windward Islands and in 1848 he returned to England and was appointed commanding engineer at Woolwich. In 1851 he was knighted and appointed governor of Malta, where he remained until 1858. He was raised to the rank of major-general in 1856. He became interested in meteorology in 1831 while superintending the repair of injuries inflicted by a severe hurricane at Barbados and engaged in a correspondence with William C. Redfield (q.v.) of Yale College. The correspondence has since been presented to Yale. He was elected a member of the Royal Society in 1839. His publications include: 'An Attempt to Develop the Law of Storms by Means of Facts Arranged According to Place and Time' (1838); and 'The Progress of the Development of the Law of Storms' (1849).

Reid, William Thomas, American educator: b. near Jacksonville, Ill., 8 Nov. 1843. He served in the Union army during the Civil War, was graduated from Harvard in 1868 and was headmaster of the High School, Newport, R. I., 1868–71. He subsequently taught in the Boston Latin School, was superintendent of the Brookline, Mass., schools 1873–5, was principal of the San Francisco Boys' High School 1875–81, and president of the University of California 1881–5. He founded the Belmont School for Boys at Belmont, Cal., the most important college preparatory school on the Pacific coast, and is its present (1904) headmaster. Consult: Adams, 'Some Famous American Schools' (1903).

Reighard, rī'gärd, **Jacob Ellsworth,** American educator: b. Laporte, Ind., 2 July 1861. He was graduated in 1882 from the University of Michigan; studied also at Freiburg-im-Breisgau; was assistant professor of zoology at the University of Michigan in 1887–8 and 1890–2; and directed the scientific work of the Michigan Fish Commission in 1890–4. In 1898 he was placed in charge of the biological survey of the Great Lakes for the United States Fish Commission. From 1892 he held the chair of zoology in the University of Michigan. He wrote 'The Anatomy of the Cat' (with H. S. Jennings, 1901).

Reign of Terror, a period of the French Revolution, conspicuous for its horrors and cruelties. It is generally considered to extend from 21 Jan. 1793, the date of the execution of Louis XIV., to 28 July 1794, when Robespierre and other sanguinary leaders were guillotined. Every day, during the Reign of Terror, victims were hurried, after a mock trial, to the scaffold, and the prisons were kept replenished by fresh captives from all parts of France. When all the nobility who could be reached had been cut off, the middle and lower classes were drawn upon for victims, and the terrorists even laid traps for each other, in their mad ambition and fear of what the future might be. At last a successful *coup d'état* was secretly organized, which resulted in the extermination of the more rabid revolutionists, and the lifting of the awful nightmare which had brooded for months over France. The Reign of Terror had its reaction in the despotism of Napoleon, and eventually in the restoration of the Bourbons.

Reikiavik, rī'kē-ä-vĭk, or **Reykjavik,** rīk'-yä'vĭk (Dan. REIKEVIG), Iceland, capital of the island, stands on the southwestern coast and is an important northern port from which considerable trade is carried on. The climate is not very severe as generally supposed. The people are unusually intelligent; the chief institutions include a public library, churches, schools. A great fair is held annually.

Reimarus, rī-mä'roos, **Hermann Samuel,** German scholar: b. Hamburg 22 Dec. 1694; d. there 1 March 1768. From about 1714 he studied at Jena, and afterward lectured at Wittenberg. He became in 1723 rector at Wismar, and in 1728 was appointed to the professorship of Hebrew in the Gymnasium of Hamburg, which he subsequently united with the professorship of mathematics. He edited the works and wrote the life of his father-in-law, 'De Vita et Scriptis J. Alb. Fabrici Commentarius' (1737). The edition of Dio Cassius, begun by Fabricius and ended by him, shows him as a philologist in a favorable light. Among his further publications are: 'Die vornehmsten Wahrheiten der natürlichen Religion' (1754); 'Betrachtungen über die Kunsttriebe der Thiere' (1762); and 'Vernunftlehre' (1756). In the 'Wolfenbüttelsche Fragmenten eines Ungenannten' (published by Lessing in 1777–8) he made an application of the rules laid down in the last-mentioned work against the positive doctrines of Christianity. Until published by Lessing it was known only in manuscript to a few of his most intimate friends. It precipitated the well-known controversy between Lessing and Pastor Goeze of Hamburg. See LESSING.

Reims, rēmz. See RHEIMS.

Reinach, rā-näk, **Joseph,** French publicist and politician: b. Paris 30 Sept. 1856. He studied law at the University and was admitted to the bar in 1877, in 1881 became secretary to Gambetta and continued such until the fall of that minister. Having earlier devoted considerable time to journalism, he returned to that field in 1886, becoming proprietor with Denayrouse of 'La Republique Française.' In 1889 he was elected deputy by the arrondissement of Digne, and was re-elected in 1893, but owing to his attitude of criticism of the Dreyfus trial and his demand for a revision, he failed of re-election in 1898. He published a number of pamphlets on this celebrated case. He is also the author of 'La Servie et la Monténégro' (1876); 'Voyage en Orient' (1879); 'Le Ministère Gambetta, Histoire et Doctrine' (1884); 'Etudes de Littérature et d'Histoire' (1888–9); 'La Politique Opportuniste' (1890); 'Petites Catilinaires' (1888–9), being his articles against Boulangism published in 'Republique Française.' He edited 'Discours et Plaidoyers politiques de Gambetta' (1881–5), and 'Dépêches Circulaires, Decrets, Proclamations et Discours de Gambetta' (1870–1).

Reinach, Salomon, French archæologist, brother of Joseph Reinach (q.v.): b. Saint-Germain-en-Laye 21 April 1858. He was educated at the Lycé Fontanes and the Ecole Normale Supérieure and was appointed to the Ecole Française d'Athènes. He made a series of excavations and investigations at Myrina near Smyrna in 1880–2 and in 1886 was an attaché at the Museum of National Antiquities at Saint-Germain-en-Laye. In 1890–2 he was assistant professor of archæology at the Ecole du Louvre, was associate curator of the National Museums in 1893 and in 1896 was elected to the Académie des Inscriptions et Belles-Lettres. He has published: 'Chronique d'Orient' (1885–91); 'Description raisonné du Musée de Saint-Germain' (1890); 'Répertoire de la Statuaire grecque et romaine' (1897–8); 'Guide illustré du Musée national de Saint-Germain' (1899); etc.

Reinbold, rīn'bōlt, **Adelheid.** See BERTHOLD, FRANZ.

Reindeer, a very distinct genus *Rangifer,* of *Cervidæ,* unique in the possession of antlers by both sexes, though those of the female are somewhat smaller. The Euro-Asiatic reindeer (*Rangifer tarandus*), is the only domesticated species of the family. It extends over the boreal regions of the eastern hemisphere between about lat. 50° and 81°, and runs into several well marked varieties. The reindeer formerly had a much wider geographical range, and is probably the *bos cervi figura* described by Cæsar as inhabiting the Hercynian forests. Its remains are found associated with hippopotami in Pleistocene formations still farther south in Europe. The antlers are not alike on both sides, the great palmated brow tine being, as a rule, developed on one side only. In the winter the fur is long, grayish brown on the body; neck, hind-quarters, and belly white. In summer the gray hair darkens into a sooty brown, and the white parts become gray, owing to the shedding of the long hairs. To the Laplander the reindeer serves as a substitute for the horse, the cow, the sheep, and the goat. It is extensively employed as a beast of draft and carriage, being broken to draw sledges, or to carry men or packages on its back; the large race of Siberia and Kamchatka being used especially for the latter purpose. A full-grown animal can draw a weight of 300 pounds, and travel at the rate of 100 miles a day, its broad deeply cleft hoofs fitting it admirably for traveling over the broken snow. In winter the herds feed in the woods on the lichens which hang from the trees, or grow upon the ground, to secure which the shovel-like brow tine and the hoofs are employed to scrape away the snow; in summer they move to the valleys to feed on the herbage and shoots, and in autumn they seek the sea coast in order to escape the mosquitoes and gad-flies, where they feed largely upon marine algæ cast upon the shore. So important are these animals to the Laplanders that they, with their entire households, accompany them on these annual migrations. In 1891 16 head of domestic reindeer were introduced into Alaska by Dr. Sheldon Jackson for the benefit of the natives who frequently suffered for food, and for purposes of transportation. The experiment proved so satisfactory that larger importations were made in subsequent years and the number in Alaska has now reached about 10,000. In 1898 Dr. Jackson, as agent of the United States government, procured a colony of Laplanders to train the natives in the care of the reindeer. The Esquimos are the chief owners and their herds promise to become a material source of wealth. Whether alive or dead every product of the reindeer serves a useful purpose.

By European mammalogists the American wild reindeer or caribou, as they are called, are considered to be co-specific with *R. tarandus,* but American students recognize two native species with some six or seven sub-species. The woodland caribou (*R. caribou*) inhabits the wooded parts of British America and the United States border from Maine to Minnesota. It is larger than most varieties of the European reindeer, and both the brow and bez tines of the antlers are much palmated; those of the female are much smaller and little palmated. It frequents marshy regions, and feeds upon leaves, grass and shoots, but in some localities at least, migrates northward in the winter in search of tree lichens (*Usnea,* etc.) and reindeer moss (*Cladonia rangiferina*). The latter is a valuable lichen, which grows in great abundance in the north of Europe, particularly in Lapland, as well as on the tundras of Siberia and the barren plains of Arctic America. It constitutes almost the sole winter food of the reindeer. Linnæus says it grows so luxuriously in Lapland that it sometimes reaches a foot in height. The reindeers scratch it up from under the snow with their feet and antlers. On this plant their existence, as well as that of the Laplanders, to whom they are indispensable, depends. Its nutritive properties depend chiefly on the gelatinous and starchy matter of which it is largely composed. Its taste is slightly pungent and acrid. When boiled it forms a jelly possessing nutritive and tonic properties.

The Barren Ground caribou (*R. arcticus*) is a smaller species with larger antlers which occupies the more central and northern barren plains of British America. This species lives in herds of enormous size, said to rival even those of the bison of former days, and migrates regularly. In the winter it moves southward to the wooded belt where it meets but does not mix with the woodland caribou, and in the spring returns to the shores of the Arctic Ocean. See CARIBOU.

Much interesting information concerning the habits of reindeer will be found in the narratives of Nordenskjöld and other Arctic travelers. Besides these consult Caton, 'Antelope and Deer of North America' (Boston, 1881); Lydekker, 'Deer of All Lands' (London, 1898); Richardson, 'Fauna Boreali-Americana' (London, 1829); Jackson, 'Annual Reports on Reindeer in Alaska' (Bureau of Education, Washington, 1892).

Reindeer Moss. See REINDEER.

Reinecke, rī'nĕk-ĕ, **Karl,** German musician: b. Altona, Prussia, 23 June 1824. He was educated by his father, a composer, and in 1834 made a successful concert tour as a pianist, later becoming court pianist to the king of Denmark. He was appointed a teacher in the Cologne Conservatory in 1851, and in 1860 was made professor of piano and composition in the Leipsic Conservatory. He has become well known as a director and as a pianist and for his interpretations of Mozart. His compositions number nearly 200, are characterized by great refinement and have a distinctly classical and occasionally a romantic touch. They include: 'Serenade'; 'Aus der Jugendzeit'; 'König Manfred' (1867); 'Auf hohen Befehl' (1886); 'Der Gouverneur von Tours' (1891); etc.

Reinhart, rīn'härt, **Benjamin Franklin,** American artist: b. Waynesburg, Pa., 29 Aug. 1829; d. Philadelphia 3 May 1885. At 15 he began to study art, and afterward took a three years' course at the National Academy, New York. In 1850 he went to Europe and studied in Paris and Düsseldorf. Returning to this country, he settled in New York in 1868. His most important works are engravings, and include: 'Cleopatra' (1865); 'Washington Receiving the News of Arnold's Treason'; 'After the Crucifixion' (1875); 'Evangeline' and 'Pocahontas' (1877); 'The Pride of the Village'; and 'Captain and the Governor' (1884); etc. To these should be added portraits of the Princess of Wales, Duchess of Newcastle, Carlyle, Tennyson, Charles O'Conor, James Buchanan, Gen. Winfield Scott, Stephen A. Douglas, and others.

Reinhart, Charles Stanley, American arttist: b. Pittsburg, 16 May 1844; d. Philadelphia 30 Aug. 1896. He went to Paris in 1867 and studied at the Atelier Suisse; in 1868 entered the Royal Academy in Munich; and in 1870 returned to the United States. Besides noteworthy illustrations for magazines in this country and in Europe, he produced works in black-and-white, water-color, and oil, many of which were exhibited at the National Academy. In 1881 he again went to Paris where he resided till 1891, and was a regular exhibitor at the Salon. Later he became a member of the Society of American Artists, New York. Among his works in black-and-white are 'An American Abroad,' 'A Little Swiss Sojourn,' and 'Reichstag Sketches'; in water-color, 'Gathering Wood' (1877); 'At the Ferry' (1878), and 'The Spanish Barber' (1884); in oil, 'The Old Life-Boat' (1880); 'Washed Ashore' (1887); and 'The Rising Tide' (1888).

Reinhart, Johann Christian, German painter: b. near Hof 24 Jan. 1761; d. Rome 8 June 1847. He began his professional education as a divinity student in Leipsic theological school, but soon showed a very decided inclination for art and became a pupil of Oeser. He afterward attended the Academy of Dresden. The liberality of his patron, the Margrave of Baireuth, enabled him to visit Rome, where he fixed his residence. His compositions are rich, nobly conceived, and full of poetic beauties, but his coloring is wanting in softness and warmth. Of the great masters he most strongly resembles Swanevelt. Among the most excellent paintings of his later years are those in the Massini Palace at Rome. He was also successful as an etcher. Consult: Baisch, 'J. Ch. Reinhart und seine Kreise' (1882).

Reinhold, rīn'hōlt, **Karl Leonard,** German philosopher: b. Vienna 26 Oct. 1758: d. Kiel 10 April 1823. His parents destined him for the church, and sent him to study with the Jesuits in Vienna. When the order was abolished in 1774 he entered the college of the regulated priests of St. Paul (generally called Barnabites), where he became, at 22, professor of philosophy. He left Austria in 1787, and the same year was appointed professor at Jena, having written a celebrated vindication of the Reformation against two chapters in Schmidt's 'History of the Germans.' In 1794 he became professor at Kiel and remained there until his death. Among his other works are 'Über das Fundament des philosophischen Wissens' (1791); 'Grundlegung einer Synonymik für den allgemeinen Sprachgebrauch in den philosophischen Wissenschaften' (1812). In his philosophy he followed Kant, Fichte, Bardili, and Jacobi. Consult 'Life' by his son E. Reinhold (1825).

Reinick, rī'nĭk, **Robert,** German artist and poet: b. Dantzic, Prussia, 22 Feb. 1805; d. Dresden 7 Feb. 1852. He studied painting in Berlin under Begas, and at the Düsseldorf Academy, and in 1844 settled at Dresden. He displayed superior artistic powers in romantic and historical subjects, and especially in such works as show the artistic union of brush and pen. Among his more important productions in art are 'Rachel and Jacob at the Well'; 'Well Near Olevano'; and numerous etchings contributed to various publications. To Rethel's 'Dance of Death' he furnished the poetical text and his other writings include: 'Song-book for Artists' (1833); 'Song-book of a Painter' (1837–44); 'Songs and Fables for the Young' (1844); Hebel's 'Allemanic Poems' (1851) which he translated into High German; 'Collected Songs' (1852); and 'Book of Poetic Fables and Stories.'

Reinicke, rī'nĭk-ĕ, **Paul René,** German painter and designer: b. Strenz-Naundorf, near Halle, 1860. Beginning his professional life at Weimar in the studio of A. Struys, he afterward became a pupil of E. von Gebhardt at Düsseldorf. In order to extend still further his art experience he went to Palestine as a pupil and assistant of Piglhein, at that time painting his panorama of the 'Crucifixion of Christ,' and executed a considerable portion of that work. While his promise as a painter was very evident he abandoned the easel on returning to Munich and became chief illustrator for the 'Fliegende Blätter.' The wonderful skill he has shown in this department of art is well known and he has depicted aristocratic life in park and promenade, ballroom and theatre, with a truthfulness and grace, with a suggestive wealth of detail and consummate finish of execution which are unrivaled. A collection of his designs, under the title 'Spiegelbilder aus dem Leben' ('Reflections from Life') has appeared in heliogravure (1890).

Reinkens, rīn'kĕns, **Joseph Hubert,** German Old Catholic bishop: b. Burtscheid, near Aix-la-Chapelle, Germany, 1 March 1821; d. Bonn 5 Jan. 1896. He was educated at Bonn and Munich, was ordained to the Roman Catholic priesthood in 1847, and became professor at Breslau in 1853. In 1870 he protested against the infallibility dogma and was suspended from his clerical offices and in 1872 was excommunicated. He became one of the leaders of the Old Catholic movement and in 1873 he was consecrated bishop of the Old Catholic Church with his official residence at Bonn and was recognized as such by the German government. He published: 'Hilarius von Poitiers' (1864); 'Revolution und Kirche' (1876); 'Lessing über Toleranz' (1883); etc.

Reinsch, rīnch, **Paul Samuel,** American historian and educator: b. Milwaukee, Wis., 1869. He was graduated from the University of Wisconsin in 1892, from its law department in 1894 and after studying abroad, became professor of political science at the University of Wisconsin in 1899. He is the author of: 'The Common Law in the Early American Colonies' (1899); 'World Politics at the End of the 19th Century as Influenced by the Oriental Situation' (1900); 'Colonial Government' (1901); 'Colonial Administration' (1903); etc.

Reis Effendi. See Effendi.

Reiske, rīs'kė, **Johann Jakob,** German philologist: b. Zörbig, Saxony, 25 Dec. 1716; d. Leipsic 14 Aug. 1774. He was educated at the University of Leipsic and devoted much attention to the study of the Semitic languages, particularly Arabic. Although abjectly poor he journeyed to Leyden where he gained access to the library and continued his study of Arabic. In 1758 he was appointed to a rectorship at the Nikolai Gymnasium at Leipsic, a position he occupied until his death, devoting himself to Greek literature in regard to which he became an authority. His works display a wide erudition and he succeeded in attracting public attention to the value of Arabic literature in the world of learning. He edited: 'Theocritus' (1765–6); 'Maximus Tyrius' (1774–5); 'Plutarch' (12 vols. 1774–82); etc.; translated from the Arabic and Greek classics and made the Latin translation of Abulfeda's 'Annales Moslemici' (1754). Most important among his writings is 'Animadversiones in Græcos Auctores' (6 vols. 1757–66). Consult: 'Autobiography,' edited and completed by his wife (1738); Morus, 'Vita Reiskii' (1777); Haupt, 'Opuscula' (1875–6).

Reit'boks, or **Reedbucks,** a genus (*Cervicapra*) of small South African antelopes, which have horns only on the heads of the males, and are never found far from water, affecting particularly marshy valleys and the reedy borders of the larger rivers. The type is *C. arundineum.* Other species are the roi rhebok, nagor and bohor.

Réjane, rā-zhăn, **Madame,** stage-name of Gabrielle (Réju) Porel, French actress: b. Paris 6 June 1857. She first appeared in 1875 in 'Revue des Deux Mondes' at the Vaudeville. She became known for her impersonation in melodramatic parts, particularly in the title-rôle of 'Madame Sans Gêne' (1893), written for her by Sardou. In 1895 she toured in the United States with much success. One of her later appearances was in 'La Passerelle' at the Vaudeville.

Rejected Addresses, a famous collection of parodies by the brothers James and Horace Smith, which was issued anonymously in 1812, and met with great success. They were written as a burlesque upon the many prominent and unsuccessful competitors for the reward offered by the management of the Drury Lane for an address to be delivered at the opening of the new theatre. Among the parodies the following are the work of James Smith: 'The Baby's Debut' (Wordsworth); 'The Hampshire Farmer's Address' (Cobbett); 'The Rebuilding' (Southey); 'Play-House Musings' (Coleridge); 'The Theatre' (Crabbe); the first stanza of 'Cui Bono' (Lord Byron); the song entitled 'Drury Lane Hustings'; and 'The Theatrical Alarm-Bell,' an imitation of the Morning Post; also travesties on 'Macbeth,' 'George Barnwell,' and 'The Stranger.' The rest are by Horace Smith. The 'Rejected Addresses' still hold a high place among the best works of their kind ever written, and their extent and variety exhibit the versatility of the authors.

Relapsing Fever, a disease so called from the fact that during apparent convalescence a relapse of all the symptoms occurs; and this may be repeated more than once. It is also called famine fever, because it has occurred during seasons of destitution since 1739. Other names for it are seven-day fever and *febris recurrens.* It is infectious and contagious. The symptoms do not usually show themselves for three or four days after exposure to the contagion. They generally begin in a shivering sensation, with headache, and with muscular pains all over the body, but especially in the limbs; then the pulse rises, and the temperature increases; there is also great thirst, pain over the stomach, and retching. Sometimes there is intense hunger, and the patient becomes extremely prostrated. On the 5th or 7th day the symptoms abate, and there is rapid amendment until about the 14th or 15th day from the beginning of the symptoms, when a relapse occurs. Three or four days afterward convalescence again begins, and in the majority of cases it goes on to complete restoration of health. Relapsing fever is not often fatal, the death-rate being about two per cent of those attacked. The treatment consists in giving gentle laxatives and cooling drinks, a light nutritious diet, and in securing to the patient perfect quietness. Relapsing fever is known to be caused by a spirillum (*Spirochæta obermeieri*), a micro organism which Obermeier of Berlin showed (1873) to be constantly present in the blood of those having this disease.

Relativ'ity. The relative is that which exists in and through its relation to something else, as opposed to the absolute, which is in and for itself. It follows, then, that every finite thing possesses only relative reality; for it is determined in all aspects of its existence by its relation to other things. Only what is infinite, and so all-inclusive, can be absolute. In the psychological sphere the so-called law of relativity is a statement of the fact that every state of consciousness is an element in the total complex of conscious life, and is therefore necessarily influenced and determined by its relation to the other elements with which it is connected. When applied to knowledge the law of relativity emphasizes the fact that knowledge is always a process in an individual mind, and depends upon the character of the impressions which the individual receives through his senses, upon his past experience, and general intellectual characteristics, as well as upon the purpose and interest that has led him to acquire any particular information. The arguments for the relativity of all knowledge, in so far as they have been used as a basis for skepticism (q.v.), have been answered by the general line of philosophical theory which points out that, in spite of individual differences of view and opinion, science presents us with a large and increasing body of propositions that are accepted as objectively binding on all. The progress of science may be described as the sifting out of such objective truths from the conflicting mass of individual beliefs and opinions. In one sense it remains true, however, that all human knowledge is relative. For such knowledge must always be incomplete, and as incomplete can never express final and absolute truth.

Consult: Hamilton, 'Lectures on Metaphysics'; Mill, 'An Examination of Sir William Hamilton's Philosophy' (1865); Green, 'Prolegomena to Ethics' (1883); Bradley, 'Appearance and Reality' (1893). J. E. Creighton,

Professor Philosophy, Cornell University.

Release, in law, is the name given to a common law conveyance, in which the word «release» is the operative verb. A release operates in five modes: (1) by passing an estate, as when a joint-tenant or coparcener conveys his estate to his co-joint tenant or coparcener; (2) by transferring a right, as when a disseissee (a person who has been unlawfully dispossessed) discharges his right to the disseissor; (3) by extinguishment, as the lord releasing his seignorial rights to his tenant; (4) by enlarging a particular estate into an estate commensurate with that of the person releasing; (5) by entry and feoffment, as a disseissee releasing to one of two disseissors, which is equivalent to entry on the property and enfeoffment after putting an end to the disseissin.

Reliance. An American yacht. See Yachting.

Relics, the mortal remains of departed saints; also, objects associated in memory with them, such as articles they used in life — clothes, vestments, the pectoral cross or the pastoral staff of a holy bishop, or the like: similar reminders of the life and death of Jesus Christ are also relics; and the religious veneration of all such relics when they are duly authenticated is expressly approved by the Catholic Church. The Council of Trent in Sec. xxv. of its acts and Decrees regarding invocation of saints condemns those who hold that «veneration and honor is not due to the relics of saints»; but all the Protestant churches teach that veneration of relics, or relic worship, is a sin of the nature of idolatry. In favor of the Catholic doctrine is cited the teaching of the early Fathers, who find both in the Hebrew scriptures and in the New Testament the highest sanction for the veneration of relics, for example, the incident of the coming to life again of a corpse on contact with the bones of the prophet Eliseus (Elisha: 2 Kings xiii. 21); and that recounted in Acts xix., 12 (compare v. 15), of sick persons being healed with «handkerchiefs or aprons» that had touched the living body of St. Paul: «there is a power,» says St. Cyril of Jerusalem (*Catecheses* xviii.) «latent even in the bodies of the just.» And the practice of the faithful in the first ages of the Church is fully consonant with this belief in the physical and spiritual efficacy of relics. The early Christians were careful to save the remains of martyrs from desecration. In the year 107 the bones of St. Ignatius, bishop of Antioch, were gathered and wrapped in fine linen, to be guarded thereafter «as a priceless treasure left to the Holy Church.» In the year 167 the faithful of Smyrna exhumed the remains of their bishop, St. Polycarp, who had been burnt alive ten years before under Marcus Aurelius, and treasured them as «more precious than costly stones and more valuable than gold.» When St. Cyprian, bishop of Carthage, was about to be decapitated (258 A.D.), the Christians cast towels and napkins before him that they might be soaked in his blood. After the persecutions were over, the practice of veneration of sacred relics persisted in the Church, as is testified by the writings of St. Ambrose, St. Augustine, St. Jerome and indeed by all the Fathers of the 4th and 5th centuries. In all ages there have been abuses connected with the practice. A canon of the Fourth Council of Lateran in the year 1215 forbade relics to be sold or to be exposed outside of their cases or shrines, and prohibited the veneration of new relics till their authenticity had been approved by the pope: and these laws are confirmed in decrees of the Council of Trent.

Relief, in old English law, a fine or composition paid by the heir of a tenant, holding by knight's service or other tenure, to the lord on the death of the ancestor for the privilege of succeeding to the estate, which by strict feudal law had lapsed or fallen to the lord on the death of the tenant.

In physical geography, the undulations or surface elevations of a country.

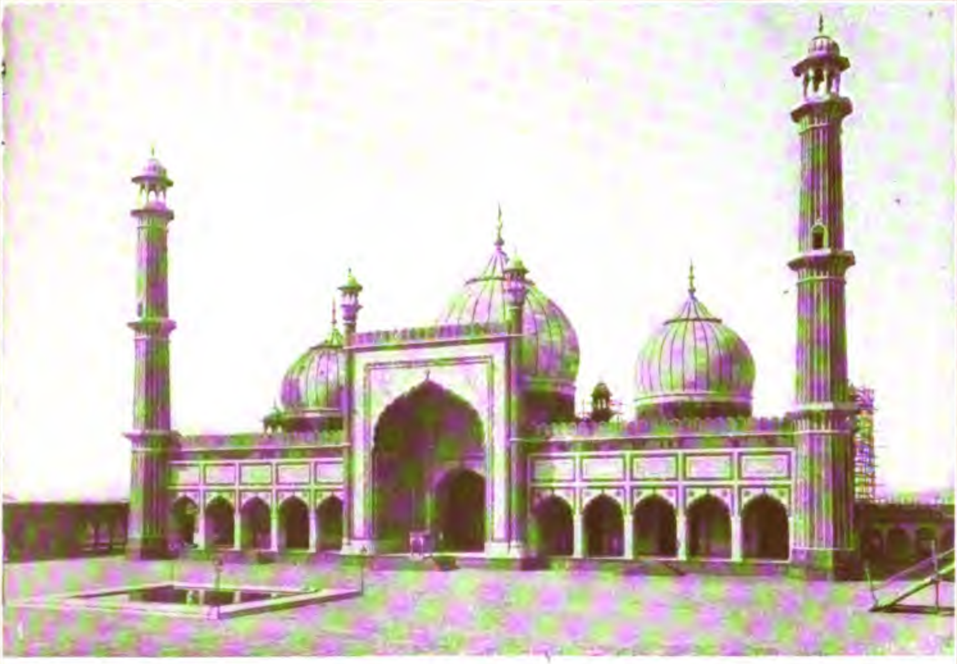
In painting, the appearance of projection and solidity in represented objects, so as to cause them to appear precisely as they are found in nature.

Relief Sculpture. See Sculpture.

Religion became an object of comparative scientific study in the 19th century. Hegel (1770–1831) was the first to combine in its study the historical, scientific, and psychologic methods, though unable from lack of accurate and full data to attain valid results. F. Max Müller (1823–1901) applied the new science of philology to myths and thus identified the Dyaus Pitar of Sanskrit with the Zeus Pater of Greek, the Jupiter of Latin, and the Tiu Fader of Teutonic, which equation he declared the greatest historical discovery of the 19th century. He also urged that speech modified thought, so that myth was partly a «disease of language.» This philological method was complemented by the anthropological one, founded by E. B. Tylor (1832—), who seeks the sources of myth not only in speech, but in the attempt to explain nature, in the attribution of inferred events to legendary or historical persons, and in the composition of myths to convey instruction. Furthermore he seeks light on religion from the rites and customs preserved in folk-lore.

Definitions of religion must be general enough to include its lowest and highest forms, and usually seem inadequate to religionists of the latter type. Definitions vary mostly as the animistic or naturistic element is made primary whereas properly they are coordinate. Animism is the worship primarily of deceased human souls, and secondarily of nature-powers upon the type of, or in close association with these. Naturism is the worship of nature-powers simply as man or animal, without analysis into body and soul, achieved by personification. Thus, E. B. Tylor defines religion as «belief in spiritual beings»; and Albert Réville, as «the sentiment of a bond uniting the human mind to that mysterious Mind whose domination of the world and of itself it recognizes, and to whom it delights in feeling itself united.» But recognition of animism and naturism as coordinate sources of religion requires a definition of this type: Religion is the belief in and worship of supersensuous and superhuman being (beings

RELIGION.



1. Mosque at Delhi, India.

2. Pool in Shaivite Temple, Madura, India.

or a being). The term supersensuous denotes both personified nature-powers and dead human souls, while both possess superhuman power. Man must have been the source, one way or other, of the supersensuous, of life, personality, soul, or spirit; while nature's vast operations supplied the notion of superhuman power.

This belief in and worship of supersensuous and superhuman being, that is, a god, whether it were tree-god, storm-god, or sole god, became, when defined and established, a creed and a cult, the latter being worship by offering, prayer, dance, and the like. Every religion must and does contain these two elements, for each is implied in the other; yet their ratio varies greatly in various religions. Thus, Brahmanism insists mainly upon a round of ritual both daily and seasonal, whereas Protestant Christianity cares chiefly for conformity to a confession of faith. Cult and creed differ also in their ratio of change. Cult remains unchanged for centuries and even millenniums; whereas the creed, though it may remain firmly attached to the same cult, changes slowly under the influence of men's thoughts in other spheres. Each lags behind the current belief at any given time, which must be learned from individual writers and speakers.

Creed began in the symbols and myths wrought by imagination, which reason elaborated into principles and dogmas. A natural object becomes a symbol when associated with a human experience, as water, which has variously symbolized purity in Judaism, fertility in Hinduism, and humility in Taoism. The appropriateness of the last symbolism appears in that water always seeks the lowest place. A natural process becomes a myth when so associated, as the course of the sun, which has formed the basis of such divine histories as those of Amaterasu, Vishnu, and Apollo. The religious products of the imagination are as reliable and instructive as are its literary products in metaphor and allegory. These symbols and myths deposited by naturism usually form the earliest stratum of scripture for any given religion; then come the legends deposited by animism especially in its cult of heroes; and finally sober history closes the record.

The relation between creed or belief and cult or worship is simple and direct. Belief in the gods excites man to a sense of dependence upon them in that he hopes for good and fears evil from them. But his sense of freedom permits him to secure the good and avert the evil by means of worship. This was naively rendered by offering to the gods whatever was useful to man, such as food — both animal and vegetable, clothing, weapons, and ornaments. The natural accompaniments of these gifts were prayer and praise, which stated the grounds or conditions upon which the gifts were made. «Give us harvest that we may give you cake.» Music and dancing were performed on the same principle; and, when lively, expressed joy, when slow, grief.

Religion as defined above is a cultural, that is, an activity proper and peculiar to man, and as such takes equal rank with the other culturals, industry, knowledge, art — whether visual or audible — and morality. Religion is as proper to man as any of these, for it springs from his normal impulses of hope and fear in presence of the world about him, whether nature or human nature; and is as peculiar to him as any other cultural, for no other mundane creature exercises it. Religion, therefore, rests upon the same firm basis as the other culturals, namely, the undeniable and unalterable constitution of men and of nature, in both of which the Infinite is ever present, though in ever varying degree. Religion shares with other culturals also the vicissitudes and final high destiny of development. It began in vague and crude notions and practices; very generally progressed; and then either suffered arrest and sometimes even regress, or under better conditions and in spite of survival and revival of outgrown traits, attained its present high, though not yet perfected and therefore final stage. The causes of this development also are not different from those for other culturals, and may be formulated as follows:

(1) Direct Causation: The predisposing cause of the development of a cultural is the potentiality (constitutive norm or principle) of mankind, and more particularly of a single race, people, or man. This is heredity with variation. The exciting cause of the same is experienced nature and man. This is environment. From their community in these two causes there arises an analogy between all cultural processes.

(2) Indirect Causation: Each cultural stands in solidarity with each other, and therefore promotes its development. This is interaction. Whenever two or more human groups of various heredities and environments meet, their mutual comparison, modification, and complementation promote development. This is intercourse.

(3) Traits: Besides these laws of external causation, there are others of inner change. These are continuity, synthesis, differentiation with unification, and classification.

That religion is thus hereditary with man, or, to speak more simply, that man has a religious nature, appears certain from the fact that no tribe of men has been found without religion, as is now granted by ethnologists. As God did not make man and leave Aristotle to make him rational, so neither did he leave Moses (or Kongtze or Manu, or Zarathustra) to make him religious. After all other causes of progress have been allowed due weight, there is a residuum of effect which implies this inner growth of man as its cause. But religious nature would have remained mere potentiality forever, had not an environment of nature and fellow-man excited it to functioning. This accords with Leibnitz's maxim: «There is nothing in mind that was not previously in sense, except the mind itself.» Of this environment, nature proved occasion for nature-worship, and man for ancestor-worship. Minor or major deities have been drawn from every kingdom of nature. Thus, the phallos and kteis were seen in water-worn stones, while trees yielded the sakaki, the pipal, the oak, the peach, the birch, and the mistletoe. Water, in the shape of wells, springs, rivers, and seas has everywhere received worship, as also has fire. The greatest gods have taken their source from sun and moon, wind and storm, heaven and earth, the last named always being a sexual pair. Divine honors have been rendered the serpent, fox, monkey, ox, jackal, and bear among animals. All these objects could do some things beyond human power, and were credited with personality in so doing. Thus they became superhuman, supersensuous beings, that is, gods. To them man turned in his various needs, as the sources of his food, as the causes of events, as the vast or infinite beyond all finite, as the incomparably beautiful, or as the guardians of right. The other taproot of religion was man-worship, whether of ancestors, heroes, or even living men. World-wide data indicate the following source for ancestor-worship. Primitive man explained his supposed temporary absence from the body in dreams by the action of a separable self, double, shade, image, or breath, as it was variously conceived. He could then explain death as the permanent absence of such spirit, and could present offerings, in return for which the dead person (supersensuous), now become also superhuman, afforded help and protection. If the deceased had been famous in war, invention, learning, or holiness, these offerings became public concern and thus hero-worship, as with Jimmu Tenno and Rama. Such a hero is sometimes worshipped while yet alive, as were Cæsar, Mikado, and Chaitanya. Besides the above objects of worship or creed, also the methods of worship or cult took their source from nature and man. Thus, the festivals at midsummer (still important in the Orient) and midwinter (New Year) were determined by the sun's solstices, as were those at spring and autumn by its equinoxes; while hours of worship were sunrise, noon, and sunset. The fourteenth and seventh days were successive divisions of the moon's 28-day period, and sacred alike in Judaism and Buddhism. The birth, puberty, and death of the individual called for ritual, while the hero added to these the dates of his victory, enlightenment, temptation, or the like. Nature gave the earliest sacred places, around tree, well, etc., while offerings to earth-gods were buried, and those to heaven-gods placed on hill-tops or burned to ascend in flame. The first sacrificer was father or chieftain, and the first sacrifices food, drink, clothing, weapons, etc. The remains of food or drink were consumed by votaries in what thus became a peace offering or communion. The accompanying prayer, music, or dancing were equally based on human models.

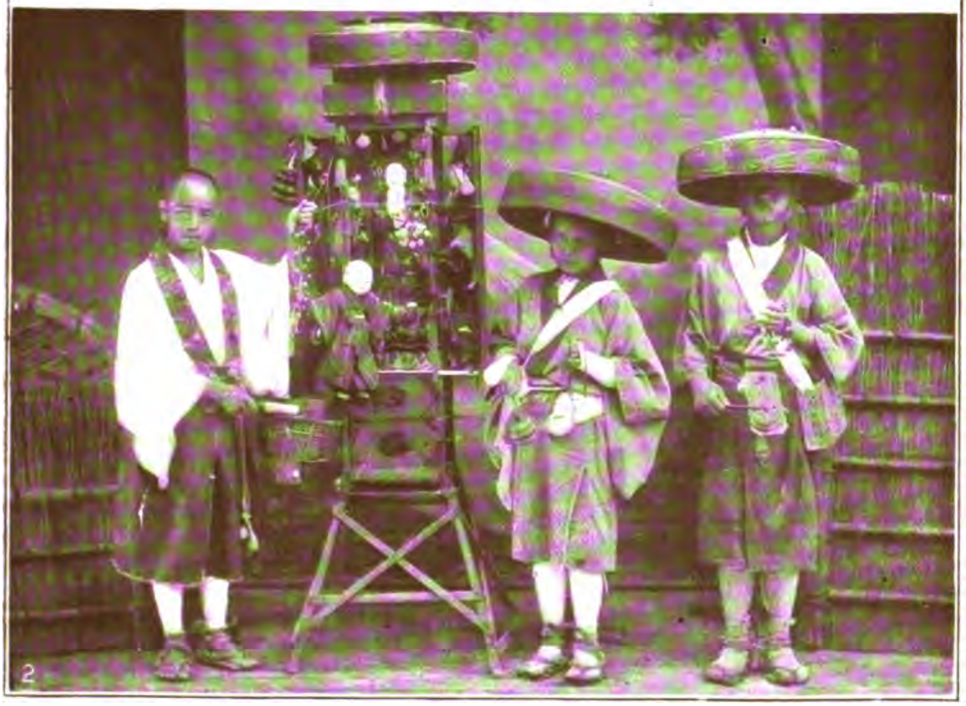
It was combined heredity and environment that imparted distinctive characteristics to the various religions. These are the emphasis on the future life by the Egyptians; the power and inscrutability of the divine among the Babylonians; loftiness and, later, ethical holiness in Jehovah among the Israelites; the duty of coöperation with Ahura Mazda to improve the world among the Persians; ascetic neglect of the world among the Hindus; insistence on the moral providence of Tien by the Chinese; visualization of the divine in beautiful forms and ennoblement of it by philosophic reflection among the Greeks; and, finally, the control of religion by state needs and hierarchical orders among the Romans. Even entire races have such characteristics. Thus, the Semites conceived their gods to be remote, austere, and self-centred, whereas the Indo-Celts made theirs immanent, genial, and related to man. The Mongolians approximated the Semites. The religious æstheticism that arose in beautiful Greece and the pessimism in sultry India show influence from environment, but the unrivaled philosophic attainments of these kindred Indo-Celtic peoples must be attributed to heredity.

First among the indirect causes of religious progress is interaction with other culturals. Thus, in industry, writing made scriptures possible. In knowledge, philosophy guided the great reforms of the 6th century B.C., made by Laotze, Kongtze, Gautama, Buddha, and Xenophanes. The Renaissance was pre-condition to the Reformation; and ever since science has corrected and interpreted religion, doing so preeminently as the science of religion or hierology, of which this article is an outline. Moreover, there is a religion of science, inasmuch as what science reveals, religion construes as the will of God. Fine art mightily aided religion when it humanized the vague and crude nature-gods by means of the idols and pictures made to represent them, the temples to house them, and the music, dance, and drama to entertain them. What we know as Greek statues were mostly Greek idols and reflected their consummate beauty back upon their divine originals. Progressing literature and music have likewise given ever nobler expression to religion, and have thus advanced religion itself. Ideals of morality and law have improved both the creed and cult of religion. Early gods sometimes reflected the current cruelty or lust; and, as morality improved, were either corrected into nobler types as was done with Zeus, or vindicated by apology as with Krishna. Other gods with better mythical implications, like Tien, Agni, Jahve, and Apollo, were gradually transformed from the nature to the moral type as their worshippers improved. In cult it was morality that motived the change from ceremonial to moral purity as the condition of approach to deity. Politics also influenced religion, because victory was attributed to the favor of the god, as when Jupiter became Optimus and Maximus over his rivals among the Latin tribes, and when the national experience of Judah led it from monolatry to monotheism.

Industry, knowledge, art, and conduct still interact with religion, and, in combination with its own inherent growth, will decide the fate of extant faiths. Thus, all polytheisms, such as Shintoism and Hinduism, are doomed by the unitary conception of the world, which is held by science; and Mohammedanism must end or mend before sculpture and painting, which it now prohibits, as well as before morality, which it now violates by polygamy. This interplay of forces exemplifies the late laureate's insight that "God fulfils himself in many ways, lest one good custom should corrupt the world."

The inner growth of religion, further influenced by interaction with the other culturals as above explained, has developed an ever nobler conception of God in terms of personality, which can differ from the human only in degree of perfection, amounting, however, in the case of the monotheistic God to infinity. God is now apprehended as Infinite Person or Absolute Spirit, and worshipped because held to possess idealized human worth in each and every sphere of culture. No man has seen this God at any time. God was revealed by himself and discovered by man through the mediation of nature and humanity aided by the other culturals. This

RELIGION



1. Japanese Temple, Kyoto. 2. A shrine of Jizo, the patron Deity of women and children

process, however, affords no ground for reducing the notion of God to any of these terms; as when B. Spinoza, the pantheist, or D. F. Strauss, the materialist, would identify him with nature; or as when Auguste Comte, the positivist, would identify him with humanity. Similarly religion is not devotion to science, as J. R. Seeley claimed; nor a «creation of the spirit» by the same imagination that produces art, as Albert Lange held; nor, finally, is it «ethics heightened, enkindled, lit up by feeling,» as Matthew Arnold taught. In particular Schleiermacher protested against this last misconception of God as a travesty of him into a universal policeman. God's function is not limited to being a judge, but includes every noble activity known to man. Religion is as unique as are the other culturals, none is false and none reducible to the other.

The other indirect cause of religious progress is intercourse among various human groups such as tribes, nations, or races. Comparison has afforded a superior religion increased confidence in itself, as when Aryans entered India. Modification of a religion has resulted from its introduction among other people, as when Buddhism overspread Asia. And complementation of one religion has been supplied by another, as when Confucianism, Taoism, and Buddhism made a religious compound in China.

The first trait or inner law of development is continuity. Nature makes no leaps in religion or elsewhere, but makes progress one step at a time. This law has made it possible to trace backward many a creed or cult through strange metamorphoses to primitive notion or rite. The law is so inevitable that even so-called founders of religion could effect their purpose only by reform of what they found at hand.

Synthesis was first observed by Hegel. Whenever a thesis exceeds moderation, it excites the opposition of some antithesis, with which it may finally coalesce into a synthesis of some larger fact that includes both. So, asceticism always tends to license, and *vice versa,* while both are sublated or taken up into normality. This was the consummate Greek insight, *mēden agan,* nothing too much. The prime example of synthesis in religion is modality, which results from excess of either one of the three mental functions in relation to the other two. Excess of volition produces the modes of moralism, legalism, or sacerdotalism; excess of intellection produces the mode of rationalism; and excess of emotion produces the mode of evangelicism, pietism, or mysticism. Ethnic religions begin with legalism as thesis, react to rationalism, and synthesize in mysticism. When a universal religion begins at synthesis as did Christianity, or at antithesis as did Buddhism, it passes to the other modes in due course. The perfection of stable balance can be only approximately realized either by individual or by people. All extant religions contain all three modes, and each mode should tolerate the other.

Differentiation with unification of quality also marks religious progress. The stone implements of various savage peoples differ little, and so do their religions. But civilized peoples show wide differences in religions. These are greatest where the peoples have moved apart, as did the Indo-Celtic nations, some eastward into Persia and India, others westward into Europe; since this isolation involved differences in all the causes of development direct or indirect. A less differentiation arose from the same cause without isolation, as in the case of the numerous sects alike in Shintoism, Hinduism, Buddhism, Islamism, and Christianity. Later on, these divisions draw together into associations, unions, and the like, to secure greater efficiency.

The various stages of development afford the best basis for the classification of religions, and hierologists differ only as to the fittest marks of these stages. Probably the best classification is into tribal, national, and universal. The national or moral religions extant are Shintoism, Confucianism, Taoism, Hinduism, Jainism, Parseeism, and Judaism; while the universal or redemptive religions are Islamism, Buddhism, and Christianity. But every like is not the same, and wide differences exist within the bounds of either class. Thus, among the universal religions, Islamism is sensuous, Buddhism is at least negatively ascetic, but Christianity recognizes both normal humanity and ideal aspirations. Again, Islamism became universal only by force; Buddhism holds exclusive sway over only Ceylon, Burma, Siam, and Nepal, all decadent nations; whereas Christianity is confessed by the great world-powers. The principles of Christianity are the highest and its forces consequently the greatest attainable, but both await correct adjustment to society by advancing science, notably sociology.

Finally, no hierologist supposes that religion will ever perish, for it makes man at home in the world and thereby supplies his chief mental need. The Lord's Prayer expresses this central truth with such incomparable purity and simplicity that it now constitutes at once the best creed and the best cult, and seems assured of universal acceptance.

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Religion, Established, or State Religion, that form of religious belief and worship which is recognized by the government or constitution of a country as national, and which enjoys certain privileges and is supported by the public treasury. The idea of complete separation of civil government and religious affairs is peculiar to modern times. In the ages before Christianity the administration of religious affairs was a function of the state and the priesthoods were orders in the state. After the triumph of Christianity the relations between church and state in the Roman empire were intimate, and the civil power freely intervened in the government of the church: the prelates of the church, too, were vested with extraordinary powers by the state, Throughout the Middle Ages the civil power was everywhere in the last resort the church's armed right hand for the enforcement of uniformity in religion. For a long time after the Reformation the uniformity of religious belief and ceremonial was held to be indispensable: in the present age, though in many countries state churches exist, controlled by the public authority and supported from the public purse, uniformity is no longer enforced by civil penalties and the subject is permitted to reject the state religion, to embrace another religion, or to ignore religion, though usually dissidents from the religion of the state suffer certain civil disabilities. It is urged in favor of the national recognition of a form of religion, that if the majority of a nation are prevented from making this public recognition of it, as a matter of primary importance to the state's welfare, then they are subjected to coercion by the minority; and if an established church uses no sort of coercion, its being supported by the state in the face of a protesting minority is no greater violation of equal rights than would be its disestablishment at the behest of the same minority.

Religions, Congress of. See CONGRESS OF RELIGIONS.

Religious Art. Two large subjects are comprised in the expression, Religious Art: Religion and Art. The union of the two finds a development in practically all races, and a not too delayed one; for aspiration and sense of beauty are almost instinctive. The worshipful tendency in man which submits him to some more than human power as an object to be adored, served and propitiated, ranges from fetishism through idolatry, ancestor worship, polytheism, or the divinization of man, and abstract dualism of a controlling good and bad spirit, up to the Christian cult of one pure Supreme Being. The Art developed under Christianity, though generically included under Religious Art, and, like its other forms, exhibiting phases and modifications due to race, environment, influence or period, is apart from, and superior to them by reason of the higher ideals which dominate it. There is, moreover, no art which Christianity has not employed with distinction in its worship, and in the variety and profusion of such productions of a religious character, not a few may be regarded as exemplars in their respective fields, especially in architecture and painting. For this reason Christian Art demands special consideration, and will not be treated under the present head. See PAINTING; POST-RENAISSANCE PAINTING; RENAISSANCE PAINTING; ROMAN CATACOMBS.

«The first impulse to art is much the same, whenever or wherever it is felt in a race,» says Lübke in his 'History of Art.' Naturally, these initial movements are of the most primitive character. Among relics of the Cave Dwellers are bowls with animals scratched or carved on them. Animal-worship is a rudimentary stage of Religion. In Egypt, coupled with ancestor-worship, it long retained a hold. The art of Egypt rose chiefly out of the latter. Some of the earliest structural efforts of Man have suggestion of Religion in them: for instance, the dolmens and cromlechs; the former, consisting of a stone placed transversally upon perpendicular ones, suggests an altar even more than a tomb: the latter, of a circle, or circles of stones surrounding a central monument. Architecture, sculpture, painting, and music are the arts which have been most drawn on, and with the most important æsthetic results, for religion. Music, though adding notably to the dignity and exaltation of public religious services by its subjugating emotional appeal, leaves no impressive signs of its effectiveness, like the other arts, and needs no further mention — the more so, as it found nothing like due development except in the Christian Religion.

The oldest monuments, those of Egypt, are architectural, and sculpture and painting were, as a rule, subsidiary to this art. Painting in its full accomplishment is the latest of those arts. Among the older races, the Egyptians rank more prominently for the blending of Art and Religion, both as to antiquity, development and monumental survival, while the Hellenic Greeks were the most conspicuous and exquisite exponents of Religious Art of all the pagan races. Sculpture became for the first time an ideal art in Greece. Sculpture in Assyria, as well as painting, was mainly for the glorification of the monarchs. In Egypt, while religious and monumental, it was singularly conventional, its stereotyped figures showing scarcely any advance for centuries. This was undoubtedly due to sacerdotal restraint. Greece, which had borrowed much in her art from both these countries, shook off the narrow restrictions which fettered it in them, and forged ahead into an exquisite independent style, distinctively her own. The highest expression of it was Religion: for the temples of the gods, and statues of the gods and goddesses themselves, were the worthiest objects of artistic emprise. True, the divinities that the Greek chisel drew from the marble were but ideal forms of human beauty invested with suggestion of moral attributes of the loftiest natural conception.

This Art blended with Religion reached its acme in Greece, in the 5th century before Christ, the age of Pericles. The Persian wars had swept away Oriental despotism, and in literature and art the Golden Age was at hand. Pericles encouraged genius of every kind. «The Drama and Sculpture both elevated the National Religion,» says Rio, in his 'L'Art Chretien.' The School of Phidias selected as some of its most inspired themes the divinities of the people for whom they worked. Pallas Athena, sprung from the brain of Jove, Goddess of Intellect, as tutelary divinity of Athens, the principal city of Greece, was naturally one of the most compelling inspirations of the sculptor's art. Nine statues of her were carved by Phidias, the master creator of that splendid art period. Sophocles, «great and pure genius,» took devotedness, ennobled by the accomplishment of a great duty, as theme of predilection for his dramas. The exalted scope of the dramatists inspired sculptors and architects with their dignified and glowing conceptions. The severe but exquisite beauty of the chaste Athena was the sculptural embodiment of the Art Spirit of that glorious epoch, the ideal impersonation of contained strength and wisdom; just as the chryselephantine statue of Zeus for the Temple of Olympia, likewise the work of Phidias, was crystallization of the national idea of the Supreme God, a divinely human type of masculine perfection.

Venus, the goddess of a decadent age, was unable to inspire the people that worshipped her with the virtues of which they stood in need; beautiful in the sensuous grace of art, but with the vivification of religious feeling evanescent. Rio, *a propos* of the Athena of Phidias, propounds a fascinating query: «Was she not the formula of a dogma lost long ago for the people but glanced at and put together by Platonic philosophy? The different traditions relative to her cult resemble the feeble rays of a primitive revelation.»

The Amazon of Greek art was a transition from Minerva to Venus, and the best exponent of this transition in dramatic poetry was Euripides, less than Sophocles or Æschylus in the association of religion and art, but who exploited more than he is commonly credited with doing the religious side of national tradition and made war against mythological absurdities. There were fifty Amazons sculptured, life-size, in the porch of the Temple of Diana, in Ephesus: guardians of her whose favorite virtue was chastity.

No people ever reveled more in the joy of living than the Greeks, and the wine that inebriated them was Beauty and Religion. But if the gods were the theoretical object of their worship, the passion for Beauty, which led for the first time to the evolution of the Ideal in Art was probably a more constraining cult. Deities peopled his land to a Greek. In gratitude for the exhilaration which was aroused within him as the physical world poured through the portals of his vision, he returned thanks to the gods who ruled the earth, the sea, the sky, by erecting to them temples in which material, mass, line, and proportion blended into a dream of structural beauty, and by bodying forth in marble the human form with every physical and ethical grace possible to Man, and giving to them names of the gods. The aroma of their superhuman beauty has survived to this day. The Renaissance caught something of the Greek spirit, but not its exuberant vitality or creative glow. There is a higher religious beauty to the best paintings of the Christian artist to one who brings religious eyes to see them with, but, barring the charm of color and the tone and depth of its pigments, a religious Greek artist might look upon the Sistine Madonna with more curiosity than reverence, while even ascetic eyes of the period of the Renaissance must needs have felt a touch of exaltation before the Pallas Athena.

Egypt was antipodal to Greece in its religious art. The mythology of the region of the Nile was a blend centuries old. The sombre shade of death was its characteristic, as life was that of the Greeks. The Egyptian temple was massive, heavy, and provocative of chastened feeling. Through the centuries, the type persisted. The Greek temple appealed more to the spectator looking at it from without than to him who beheld its interior, and the severe Doric style was succeeded by the greater ornateness of the Ionic and the Corinthian. The Egyptian temple, like the Indian, consisted of a cluster of different parts enclosing a small sacred shrine in which reposed the god. A row of Sphinxes or ram-headed Colossi, all alike, and in an attitude of repose which expressed reserve and stolid dignity, but little grace, led up to the entrance: two similar façades convergent toward the top with a narrow gate between. This entrance led to an open court with porticoes. Beyond were other halls, leading to the small sanctuary, or cell, only a few feet in dimension, in whose gloom reposed the god. There were no windows in the temples and the great wall spaces, as well as the columns and cornice, were covered with hieroglyphic inscription, figures of gods and of rulers, painted in bright, primary colors. There is no high ideal feeling in symbolic religious portrayal. The gods are distinguished from humans in the Egyptian paintings by different heads of animals and by the dress they wore. These animals were hieroglyphic signs of their names. Thus Thoth had the head of an ibis; Anubis, that of a dog; Hathor, that of a cow; the goddess of Neith, that of a lioness, and so on. The dress of the gods resembled the short ancient undress of women, and they had a special beard, longer by two inches than that of mortals, and turned up at the end. They are not living things like the Greek gods, but merely important symbols. The ancient mythology of Egypt supposed gods, then demi-gods, then the mysterious Manes. Ptah was the father of the gods, and his four sons, Ra, Shu, Seb and Osiris, represented respectively fire, air, earth, and water. Isis was the sister and wife of Osiris, and Horus was their son. Anubis was also son of Osiris. Set, the evil god, tried to destroy Osiris, who was protected by Horus. A symbol of Horus, a great sun-disk with widespread colored wings, was sculptured over the doors of the temples to drive away unclean spirits.

Another note of Egyptian art is the Uræus, a venomous Egyptian serpent which always encircled the diadem of the Pharaohs, as a symbol of royal power, because of its swift effects for life or death. The sun-god, Ra, conquered the Uræus for his diadem. Snakes were kept in the temples. Plutarch says the snake was revered as something sacred because of its power of gliding along without the aid of any limbs, like the stars.

Different cities were devoted to this or that special god. Memphis was faithful to Ptah. Abydos to Osiris, Denderah to the goddess Hathor. From the oldest records, the pyramid texts, the development of religion was complete and remained practically the same thereafter, though there were myths and much irreconcilable confusion. The sun-god, Ra, was common to all Egypt. There was a close relation between kings and gods and priests. The kings conciliated the gods by building and maintaining temples. King Tehuti-mes III. (1533 B.C.) built the temple to Osiris at Abydos. On an obelisk is an inscription «King Tehuti-mes has caused this monument to be erected in remembrance of his father, the god Herem-Khu (that is, Helios, the Sun).» Khamnes, son of Rameses II., was high priest of Ptah at Memphis, and did much to restore the worship of Apis, the living type of Ptah-Sakari. Osiris at intervals became incarnate in a bull with exotic markings. The Serapeum was the tomb of the bulls thus glorified by the indwelling of the god, who if they lived twenty years, were ceremoniously slain, and their exuviæ preserved and revered.

Painting with the Egyptians was only a

kind of picture-writing, although interesting as decoration. Even subjects that seem secular and domestic had affiliation with religion which they would lack in another race. Agriculture was to be practised, for instance, in Elysian fields after death. The colors employed were black, green, red, yellow, blue, brown, and white. The colors employed for the pictured gods were vivid red, green, yellow, or blue. Religious, historical and domestic themes were treated with considerable uniformity. The worship of the dead, rites of burial, weighing the departed soul in scales, transportation of mummies in funeral barges, the king offering gifts to the god, are some of the religious subjects. A painted chronicle, that is the note of Egyptian Art. Leipsius calls the art of Egypt «a child: a strictly, heedfully, narrowly brought-up child.» The child never grew up. A network of sacerdotal prescription enmeshed all the monuments of man's life and paralyzed individuality and originality in Art. Painting was not merely on flat surfaces. The Egyptians colored their bas-reliefs, and the designs incised deeply in the stone, which are called *bas-reliefs en creux,* or hollowed reliefs. The lotos, or water-lily of the Nile, was anciently used in religious rites and figured in art decoration. It was carried from Egypt to Assyria and has place with the fir-cones and honeysuckles, introduced in later sculpture in Nineveh. In India, it serves as a Buddhist symbol, the petals in the wheel-like form of the flower typifying perpetual cycles of existence.

The religious art of Egypt is inferior to that of Greece not only because of its being symbolic, restricted, sombre and heavy, but because the idea of divinity with the Egyptians, in Art, at least, was not anthropomorphic. Their gods had animal heads. A god, therefore, was non-human and monstrous in this respect, just as the hundred-armed god of the Buddhists is in Indian Art. Symbolism does not lend itself to idealism: hence its lack of development. The art of Greece and Egypt, however, affords the two most significant examples of religious art among the nations of antiquity. Roman art, borrowed from the Greek, and although it created no ideal forms in Art which were original, it produced sculpture only second to Grecian, either the work of Greek artists after the subjugation of Greece by the Romans, or imitation of Greek ideals by Roman sculptors. Sculpture as an accessory to architecture and in portraiture was carried to much perfection under the Roman emperors who succeeded Augustus. In the Arch of Titus, erected as a memorial of the conquest of Jerusalem, there was represented a procession carrying away the spoils of the Temple, including the Ark, and the seven-branched candlestick. Although this is not religious art, for it only commemorates an Imperial victory, yet is is mentioned as interesting that the two art products of the Jews which were most sacred should thus be exhibited as a note of the triumph expressed in a monument to the glory of a pagan emperor. Cameo-cutting and bas-reliefs on sarcophagi were artistic productions finely executed, in the decline of the Roman Empire, when the arts had also declined.

In architecture, the Romans copied and modified from Etruscan buildings in their earlier work and from the Greeks in their later. They brought the arch and the vaulted roof to great perfection. The Corinthian order, which they largely affected, was modified, in their efforts to lend it fulness and strength, into the Composite or Roman order. The Pantheon of Rome, the finest monument of Roman architecture, was built by Agrippa (13 A.D.). It was one of the grandest buildings of the ancient world. The Tomb of Hadrian, the Castle of San Angelo to-day, surmounted by an angel, surpassed any sepulchral monument of its time.

The religious art of the other nations of antiquity was inferior to the manifestations of it already recorded. There is no sculpture or painting of an early date in Chaldæa or Babylon, though Chaldæan traditions have been the foundation of the arts of western Asia. They worshipped heavenly bodies and the temples were also observatories. Phœnician Art (q.v.) is a mixture of Assyrian and Egyptian. In Assyrian art there are winged figures of bulls with bearded human heads. There are no traces of Median art. The religion of the Persians was based on a dualism of essentially moral character. The Kingdom of Light or Ormuzd, Goodness, is opposed to the Kingdom of Ahriman or Darkness. In Persian art (q.v.), the King is represented worshipping Ormuzd, the God of Light, with Ferouher, or Wisdom, over his head, as a man with the wings and tail of a bird. The stone altars on the mountain tops are the chief monuments of Persian religious art, though it was really the followers of Zoroaster who venerated fire as a symbol of the Deity, Ormuzd.

Religious art in India appears to have begun with Asoka, who adopted Buddhism, and was the Buddhist Constantine. Buddhist architecture is the oldest style, and it embraces monasteries hewn out of the solid rock; high memorial mounds, or Topes; Pagodas, detached buildings surrounded by a series of walls, and Mosques, built by Mohammedan conquerors who brought their own style with them and combined with it native ornamentation. In the very first period Indian art attained a distinctive style, which was employed in religious monuments. The Brahminical sects adopted it and later it was transformed by profane ornamentation. The founder of Buddhism, Gotama Sakyasinha, reformed the old Hindu pantheism, Brahmanism. He is represented seated on the sacred lotos which is supported by the avatar of Sakya, the lion. There is some similarity between the Buddhist temples and those of Christianity. Rows of pillars separate the nave from the aisles, and a small dagoba, or shrine, rises at the end of the cave (the temples were originally monasteries cut from the rock) in which is the seated image of Buddha. This is where the altar would be in a Christian church. The Mosques are the most remarkable of all the Indian buildings.

Mohammedan religious art has peculiar restrictions and yet quite a distinct character. «Images,» it is said in the Koran, «are things to be held in abhorrence.» Tradition also ascribes to Mohammed's oral utterances this one: «Woe unto him who paints the likeness of a living thing: on the Day of Judgment those whom he has depicted will rise up out of the grave and ask him for their souls. Then, verily, unable to make the work of his hands live, will he be consumed in everlasting flames.» With figures thus barred, the art of the East is mainly decorative. All races alike begin with surface decoration, whether wall painting, glass painting or tapestry. But the evolution of Western art led to the treatment of a flat surface in a way to remove the sense of flatness. Color is only a means in painting that has reached a developed state, but it remains an end in itself for the East which regards it as an ornament, and the Oriental feels no need of anything in art that transcends ornament. Arab predilection for this, and the exclusion of animal forms, lead to designs in which geometrical figures, vegetable forms, and letters or sentences from the Koran are the elements. With sculpture banned as to its principal object, and only flat ornament of conventional design, there is not much to be said for Mohammedan religious art in sculpture and painting. The same color effects are found in secular and in sacred buildings. In the beginning, Mohammedans found that Christian churches served well enough for their religious rites. The earliest mosques were built by Christian architects. Almost every new style of architecture is the result of the requirements of a new religion. Gradually, therefore, the Arabesque style of decoration asserted itself, and the horseshoe arch originated in their architecture. This novelty became and has continued a distinctive feature of Mohammedan Architecture.

In a mosque, a portico surrounds a fountain for ablutions: in the southeast part is a pulpit, and in the direction in which Mecca lies is a sacred niche (Mihrab) toward which the faithful must look when they pray. Opposite the pulpit was a desk for the Koran. The simplicity of the earlier mosques gave way to an infinite variety of arcaded courts, gateways, domes and minarets, the dome constituting the leading feature. The Moors introduced a ceiling known as the *stalactite,* which became as distinctive of their architecture as the horseshoe arch. The minarets are tall towers of several stories from which the muezzin calls the faithful to prayer. Sometimes the outside of a mosque is without ornament: but the flat surfaces of the interior are always profusely decorated in the richest colors.

Arabian art first acquired a distinctive character and a settled style in Egypt, but Saracenic Art touched its highest beauty in Spain. Everywhere lavish color and profuse ornamentation remain its features. When the Mohammedans conquered Constantinople, 1483 A.D., they took Santa Sophia as their model and thereafter their buildings are more or less perfect copies of that work of Justinian. The Mosque of Suleiman II., at Adrianople, is an exact copy in plan and form, though differing in detail. The Mohammedan's chief thought was religion, and he made all the arts subservient to it. The most beautiful Persian and Turkish rugs are prayer-rugs. The Smyrna prayer-rugs have a plain centre, green, blue, yellow, ivory, or red, with the prayer point supported by two columns, from which hangs a lamp. Sometimes, the pillars are omitted and there is a modification of the Tree of Life. Bokhara prayer-rugs have the centre field divided into four sections by a large cross. At the appointed hour for prayer, the devout Mohammedan spreads his prayer-rug with the Mihrab (niche) toward Mecca, and prostrates himself, his head resting on the rug at the point, his hands outstretched. There are small prayer-rugs for the children, and occasionally rugs have two or three niches, as if intended for a family rug. The most exquisite rugs are sent to Mecca as propitiatory offerings. The mosque at Meshed is famous for its gorgeous carpets, whose soft, glowing colors harmonize exquisitely with the iridescent effects of the tiled walls.

A reflection made by A. F. Rio, in the introduction to his ‹l'Art Chretien,› is interesting as a theory to account for the note, so to speak, of religious beliefs of the various peoples, which flowed more or less into productions of their art. It may serve as conclusion to this article. He says: «There is a point of view which dominates all the others in the respective doctrines of the peoples of antiquity: that, namely, which shows us the special vocation of each race in the religious dogma which has determined more particularly its intellectual and moral development, and which has been assigned it as its proper inheritance from the debris of primitive beliefs, after the catastrophe which had as a consequence the dispersion of the human race.»

«The share that fell to Indians (East) was the dogma of the divine incarnation, on which they have constructed their gigantic epics: that to the Phœnicians, the mysterious dogma of an original prevarication which demanded incessant expiation through immolation of human victims: that to the Persians, the constant antagonism between the two Principles which dispute for the empire of the World and that of Conscience: that to the Egyptians, the dogma of immortality in view of the recompenses and chastisements after death: that to the Greeks, the double degradation of man through his fall, that of the body and of the soul; as if this privileged race had heard distinctly through the rumbling of the ages only these words of Genesis: ‹God created man after His own image.› This race gave itself instinctively the mission of rehabilitating the human creature as well in his faculties as in his form: in a word to introduce into the world the notion of the Ideal. Another even more privileged people, the Jews, had been appointed with view to their honor of the True, as the Greeks were to the honor of the Beautiful.»

Sir W. M. Conway finds the art in which different peoples have excelled due to the ideal they strive to express: that of persistence, among the Egyptians resulting in architecture; of reserve, among the Greeks, in perfect sculpture; the Mediæval ideal producing chivalry, feudalism and Gothic architecture: the Renaissance ideal, study of antiquity, revival of learning, tendency toward despotism in government, and the great Italian and German schools of painting.

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Religious Education. Religious education is a phrase (recently become technical) to denote a particular type of education which makes full use of the religious and moral forces in human development. The rise of this new educational ideal is due to a better understanding of the processes of mental and spiritual growth, to better methods in child training, and to better knowledge of the Bible as the primary means of religious and moral instruction. Historical and psychological study have brought in a new era of thought, for they teach us to look at the past not as a flat picture, but as one having shading and perspective. The story of the past is a story of development; the race has slowly grown, stage by stage, from the most primitive condition to the present relatively high plane of civilization. Man has progressed physically, intellectually, morally and spiritually through the ages.

In this development religion and morality have been chief factors. Progress has been largely accomplished under the guidance and stimulus of the religious and moral instincts native to mankind. There has been an increasing perception of truth, right and goodness, an ever higher idea of God has been gained, and it has become recognized that the Bible is a record of this spiritual experience and growth of men.

Religion is no longer conceived as a mystical and unrelated element in life, coming and going without any known order, an intermittent activity in his world of an absentee God; instead, religion is that essential element or attribute of finite personality which unites it with the infinite, and promotes the development of the highest humanity. Also the Bible appears, not as an epitome of all knowledge, cast down from heaven complete, to make human experience and thought unnecessary, but as a helpful account of the religious experiences and ideas of the past as men have progressed under God's guidance and blessing toward the divine ideal.

One great discovery of modern education is that, since the individual is an organic unit, the true education for him must be an organic unity. The whole man is the subject of education; he does not develop piecemeal, first on one side and then on the other; he does not grow by the attaching of one kind of knowledge to him on week-days and another kind on Sunday. He develops by an innate process. The chief object of education is not to supply information, but to develop character and social efficiency. The distinction between instruction and education is clarifying: instruction is the act of imparting information, education is the process that includes all means of development. Education includes instruction as one of its features, but it is a world-movement which makes for the realization of world-ends. The clearest analogy for education is drawn from plant life: the acorn grows into the oak because of its own inherent vitality and destination; it is assisted in this growth by the soil, the rain and the sunshine. Similarly the child grows into the man because it has the potency and destiny of manhood; it is assisted in this growth by an environment which if ideal contains all those elements that are most helpful to physical, intellectual, moral and spiritual development.

The business of religious education is to create this ideal environment for every child, so that his growing personality may lack none of those things required for perfect self-realization. Religion cannot be thrust into the child by instruction in the dogmas, the ritual, or the history of ecclesiastical institutions; religion is rather a force within the child which makes for his highest development and well-being. Religious education must therefore operate to give this inner force the best possible opportunity to accomplish its results. For this reason the best education is religious education, that is, an education which recognizes the function of religion in human development and makes due provision for its contribution. All education is essentially religious, for religion seeks the highest development of men individually and socially, and all that contributes to this end is religious.

Here also morality finds its close connection with religion. Our conduct toward ourselves and toward others springs from our view of life, our sense of duty, our conception of goodness. These belong to human personality; they arise within one. They constitute the religious elements of mankind; they are factors of our development. Religion therefore finds one of its chief ends and expressions in conduct. Not all ethical feeling and instruction rest consciously or confessedly on this religious foundation; but if religion is what it is here supposed to be, religion does in fact determine humanity, for the principles of conduct are those which grow out of one's world-view.

With regard to the material which may be used for religious education, it is now clearly seen that the child is not a miniature man, capable in a degree proportionate to his size of all the sensations, emotions and ideas of grown people. Children do not have and cannot have those theological ideas, spiritual upheavals, mental struggles and moral experiences which belong to adolescence and maturity. Therefore literature or material of any kind which describes or is designed to arouse or to inculcate these phenomena of adolescent and adult life is not adapted to children, and should not be used in teaching them. This means, for instance, that the Bible, which largely records adult ideas and describes adult experiences, must be wisely used with children. Only such material as is appropriate to the several stages of human growth should be employed in the religious training provided for these stages. And other material from outside the Bible which can be made helpful to children in their development should also be used at suitable times and in suitable ways. It is clear that the Bible, rightly interpreted and rightly used, will be the most valuable literature for religious education. This is just because the Bible gives a religious history of that nation in the past which achieved the noblest religious ideas and the highest religious experiences. But it will also be found that there has been much true religious thought and experience, pre-Christian, non-Christian and Christian, which has found record in other literature than the Bible; these writings, too, whether past or present, will be used as they are qualified for promoting religious education.

In addition, there is the religious thought and experience of the present time, written and unwritten. This means of religious nurture is largely ignored. The great religious events, activities, ideas and experiences of the past are made much of, while the great religious events, activities, ideas and experiences of the present are regarded as without official approval, or too commonplace, or too progressive to be treated as material for religious education. The virtues of living men, the heroisms of every-day life, the deep significance of present events, the value of scientific discoveries, the helpfulness of new truth and of the re-statements of old truth, modern missionary movements, modern charities institutional and individual — these and other phenomena of religion and morality in our own day should be wisely and faithfully used.

The religious education of the present time is being given to the rising generation by a large number of agencies. The common notion that the home, the church and the Sunday-school are practically the only teachers of religion and morality is erroneous. These are certainly the primary agencies, but there are also the universities, colleges, and public and private schools of all grades; the Young Men's and Young Women's Christian associations; the Young People's societies of all sects and kinds; the libraries which are greatly extending and augmenting their effectiveness; and the public press, of which the religious papers exercise some influence upon a limited number of readers, while the daily press is now one of the greatest means of spreading religious and moral ideals.

Of general education in America the chief instrument is obviously the public schools. The entire period of development — childhood, youth and adolescence, from six to eighteen (or even to twenty-five) years of age, is now conducted by the state, which undertakes to bring the child into possession of the general knowledge, skill and character which are regarded as necessary to good citizenship. Increasingly the American people have turned their children over to state education, expecting it to develop them completely into manhood and womanhood. The home and the church contribute less than formerly to the education of the whole rising generation, because of the multiplicity of interests and the pressure of business on the modern home, and because of the obsolete or ineffective ideas and methods of many of the churches. The belief widely prevails that modern education is complete without that special religious training and knowledge of the Bible which previously were required. The argument runs thus: the education furnished by the state, under the direction of the ablest educators, may reasonably be understood to embrace all those elements of culture which are essential to a complete development of the young; and since the public schools make little or no specific use of the well-known means of religious and moral instruction, these should be considered as no longer necessary to a perfect education.

But the state should enlarge and improve its education in accordance with the best pedagogical ideas to meet our national needs; it should include in its aims and methods all those elements which are necessary to a full development of men and women. Essential elements of education like religion and morality cannot consistently or wisely be left to other institutions to supply *in toto*, for two reasons: (1) these other institutions, such as the family and the church, often fail, wholly or in part, to make their proper contributions to the growth of the child; (2) no true education is possible where the essential elements are given in isolation instead of in correlation.

Certainly the home should follow a higher ideal and should achieve a greater efficiency; parents should anew consecrate themselves to the work of making the home the best possible environment for the growing child, where influence, instruction and stimulus will cause the best that is in the child to appear; particularly the religion and morality essential to the highest development should here enter into the environment so as to direct the growth of the child. The public schools cannot accomplish perfect results when they must do the work of the home in addition to their own.

The church also should set itself to learn its true function in the present time, and to discover how it can perform this. Some individuals and denominations of the church have made effort to adjust themselves to the progress of civilization, to the expanding ideas of modern thought, to the improved world-view, to the change of interest from speculation to actual life, and from an extreme individualism to a vastly better conception of men as interrelated and mutually dependent upon one another for higher development. But generally the churches have stood for the ideas, methods and viewpoints of the past; they have wished to confine advancing civilization within the bounds of previous centuries; they have sought to perpetuate doctrines and practices which were once expressive of current thought and experience and were therefore useful, but which have been superseded by clearer vision of truth, by a better interpretation of the Bible, and by changed ideas concerning the best way of doing things. The church is indeed the great conservative force in human civilization, and a conservative force is essential. But conservatism should not become obstructive, hindering growth and resisting progress.

The present movement for religious education, outside the practice of the Roman Catholic Church, which has always insisted on religious education, has come out of the educational world rather than out of the church, because of the inertia and narrowness of ecclesiasticism. It is inspired and guided by men who belong to the church and represent its best product, but whose life-work has been in the field of education. Certain branches of the church have made much of education; in America, in former years, the schools and colleges were often church foundations, to train the ministry and to spread intelligence in the interest of religion. But now the public schools have no relation to the churches; and many private schools which were formerly church schools have freed themselves from ecclesiastical supervision. The educational world has kept step with progress, and from it has come the demand that religion and morality shall be restored to their true place in education. This forward movement arose during the 19th century, gaining clearness and force as the sciences of psychology, pedagogy and history advanced, until with the opening of the 20th century the movement in America reached such a stage of development that a new era may be said to have been inaugurated.

The most conspicuous evidence of this was the establishment of the Religious Education Association at Chicago in February 1903, by one of the most remarkable conventions ever held in the United States. This representative national organization, in its second year only, consists of some 250 officers and 2,000 members, including many of the leaders in the religious and educational activities of our day. The purpose of the association is to unite for mutual helpfulness all those who are engaged in religious education through whatever agencies or means; to improve the current religious education by thought, conference and investigation; to promote such education by spreading approved ideals, principles and methods; and to increase the efficiency of all individuals and agencies by unifying, stimulating and developing all those forces which together can secure to religion and morality their true place and their proper influence. The association simply gives expression to the widespread popular demand that education shall make use of religion and morality according to the best light that has now been attained regarding these vital elements of human development. See PARISH SCHOOLS.

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Religious Liberty, or **Liberty of Conscience,** is the recognition and assertion by the state or government of the right of every man, in the profession of opinion and in the outward forms and requirements of religion, to do or abstain from doing whatever his individual conscience or sense of right suggests. Religious liberty is opposed to the imposition by the state of any arbitrary restrictions upon forms of worship or the propagation of religious opinions, or to the enacting of any binding forms of worship or belief. The limit of religious liberty is necessarily the right of the state to maintain order, prevent excesses, and guard against encroachments upon private right. The principle of religious liberty has come very slowly to be understood. The state of the ancient world in regard to questions of liberty of conscience was somewhat different from that of the modern. Many national religions did not make universal pretensions, and within their limits there was considerable latitude; the worshipper of one god did not necessarily impugn the authority of another. Yet instances of intolerance are to be found, as in the case of Socrates, even in the most liberal states. When Christianity appeared the case was altered, and it speedily drew on itself a treatment different from that which merely national religions had received from the rulers of the world. Christianity early developed within itself sects which did not manifest toward each other a very tolerant spirit; but it was only when the civil power had been gained to its side that these differences could assume the form of open repression and persecution. It was then found that the persecuting spirit could distinguish a church not less than a secular government, and, indeed, that from the constant occupation of the former with religious affairs the danger of persecution from it was much greater than from the most intolerant civil government. In the organization of civil and ecclesiastical government which prevailed from Constantine to the Reformation persecution was in general only limited by dissent, and universal submission to the dominant church became the condition of religious peace throughout Christendom, while religious liberty was unknown.

The contest of opinion begun at the Reformation had the effect of establishing religious liberty, as far as it at present exists, but the principle itself was so far from being understood and accepted in its purity by either party that it hardly suggested itself even to the most enlightened reasoners of that age. The contest between the reformers and the church was primarily one of authority; and so great was the regard of the former to the authority of their own confessions, that in Germany itself the common dangers they encountered from the Roman Catholics could hardly keep the Lutherans and Calvinists united during actual hostilities.

In Great Britain even civil liberty, jealously maintained, was not understood, by the dominant party at least, to import religious liberty. Active measures of intolerance were adopted against Dissenters in the reign of Queen Anne. Even in the reign of George III. conditions were attached to the toleration of Dissenting preachers. It was not till the 53d year of this reign that Unitarians were included within the benefits of the toleration acts.

Religious liberty was introduced in Prussia by Frederick the Great, but contravened by his immediate successor. The state at present in Prussia, without, perhaps, actually dictating to private individuals, maintains a vigilant control over ecclesiastical organization, the education of the clergy, and all public matters connected with religion, which only do not affect religious liberty if they are strictly confined to state-protected churches.

Joseph II. of Austria found his Protestant subjects sufficiently advanced to be beyond the need of his control, and reserved such persecution as he was disposed to exercise for the Roman Catholics. By his religious reforms he excited a revolt among his Belgian subjects, which was only terminated under his successor. Religious liberty has only been established in Austria during the present reign. Italy first enjoyed the same advantage under Victor Emmanuel II. The government of France, even since the Revolution, has always been of so paternal a character that it is still somewhat doubtful on what foundation the liberties of Frenchmen rest. In Italy the Waldenses were emancipated in that year, 1848, which marks a new era of religious progress throughout Europe. The constitutions granted at that memorable epoch guaranteed the free exercise of divine worship. Since 1870 the Free Italian churches and many others have sprung into life. In Spain religious liberty dates its feeble beginnings from 1869. Concessions are neutralized by certain restrictions, for the constitution of 1876 limits the liberty of those who are not Roman Catholics to worship in private houses.

In Holland and Scandinavia, even with church establishments, perfect religious equality is enjoyed. And by the treaty of Berlin, 1878, the sultan's government was forced to this position, that in no part of the Ottoman empire shall difference of religion be alleged against any person as a ground for exclusion or incapacity as regards the discharge of civil and political rights, admission to the public employments, functions, and honors, or the exercise of the various professions and industries. The outrageous persecutions which have fallen on the Armenians in contravention of this treaty, and which the powers of Europe failed to prevent and punish, are among the burning shames of a century which won many victories for the right of rights.

The area of toleration has been enlarged by the official action of China in granting to the different European nations the right of sending Christian missionaries, not only to the port cities, but to the interior of that vast empire. The Chinese government has given repeated assurance of its belief that the doctrines of Christianity and the practice of them were for good. The fanatical uprising of those who hate all foreign influences will not permanently diminish the area of religious liberty in the Far East.

America is the great home not so much of toleration as of true liberty. In the United States the government has no authority to interfere with religion. The fullest liberty is possible only where the church and state are separate. From the beginning of our organized national life this separation has prevailed and been the fundamental law and practice of our country. Here the Jews have had freedom and have been treated with a friendliness never elsewhere shown to them. America is the standing reply to those who believe that religion needs the support and guidance of the state. Christian progress in our country has been more rapid than the progress of the population, and it is as true to-day as when De Tocqueville wrote that «there is no country in the whole world in which the Christian religion retains a greater influence over the souls of men than in America.»

Probably in no other country than America could such a Congress of Religions have been held as that which was the crowning feature of the Columbian World's Fair at Chicago. By that remarkable gathering the bonds of brotherhood and of true toleration were enlarged. Roman Catholics and Protestants for the first time sat together in a great assembly for 17 days in the spirit of fraternity and kindliness. The representatives of the great non-Christian faiths were treated with perfect courtesy, and illustrated the spirit of courtesy themselves. Many Christians learned a new lesson, following the teachings of Sir Monier Williams, not to shut their eyes to any truth or virtue which may be found in the non-Christian characters and non-Christian writings.

From this review it appears that toleration has been slowly advancing since the Reformation, and that its recent progress has been extensive. Even in the most advanced countries, however, the state of public opinion on this subject is still far from being satisfactory. Liberty is correlative with responsibility, and as on philosophical grounds a man cannot be held responsible further than he is free, so in practical affairs no man can competently discharge his responsibilities who is denied freedom of action. Religion primarily concerns the conscience, which is the seat of human liberty, if that liberty exists anywhere. The value of religious observances depends upon their being the expression of religious thoughts and opinions. To compel a man who holds certain opinions to observe certain practices corresponding with them is to deprive him of the opportunity of giving free and natural expression to his opinions. If this is done in religion he is deprived of the natural outlet for his feelings of reverence and devotion. The spontaneity necessary to the discharge of his avowed responsibilities does not exist, and his religious life is thwarted and deadened. Thus compulsion in religion is injurious not only to those who resist, but still more to those who acquiesce; and freedom is indispensable, as much for the protection of those who are in the right as for those who, in the view of authority, are in the wrong. The religion which is imposed by authority is the religion of the rulers and not of the ruled. Consult: Johnston, ‹Religious Liberty in Maryland and Rhode Island.›

Religious Orders. See ORDERS, RELIGIOUS.

Religious Sects. From the earliest days of the world's history man has been more or less a religious creature. Almost invariably he has had a god, or several of them, to whom he looked for protection. At times these gods have been crude fetishes of whittled wood or roughly hewn stone; at times they have assumed the form of animals or reptiles, or have appeared as cruel monsters eager for the life-blood of those who reverenced them. But, however they may have come, man has worshipped them, because religion, as represented in the worship of a supernatural power, is interwoven with the entire fabric of human nature. The religious «sect,» however, is of more recent origin, for while primitive man could worship his crude fetishes blindly, it was necessary that he should learn to think before he could attempt to distinguish between the various attributes of the Infinite, that from them he might construct those well-marked divisions of faith, or creed, which are such an inevitable result of the varying phases of human thought. To-day the term «sect» is applied to those bodies of men who have announced their decisions to follow the opinions or doctrines of some philosophical or theological teacher. Of course, to the Roman Catholic all religious bodies that are not actually in affiliation with her communion are classed as sectarian, but such a definition is not the general one, the word «sect» being used to differentiate separate organizations rather than to call attention to comparatively inconsequential differences of opinion. Thus, for example, the High and Low Church factions in the Church of England, or, in this country, the Protestant Episcopal Church, are not regarded as separate sects but as parties, or schools, within the same communion: whereas the various bodies of Baptists in America are denominated as «sects,» not so much because of their differences in doctrinal matters, which in some instances are slight, but for the reason that they are under separate church government. While there were sects among the ancient Jews and Greeks the coming of Christianity, with its wide field for speculation, opened the way for a more general promulgation of individual opinion, and the following list of the most important organizations of this and other days indicates that there has been no lack of teachers and prophets to preach new gospels to those who would hear:

Abecedarians.— A sect of German Anabaptists, led by Nicholas Stork, a weaver, who opposed the simplest forms of education, even the learning of the A B C's, on the ground that it prevented divine illumination and hindered spiritual sanctification. Extinct.

Abelites.— An African sect which opposed procreation on the ground that it was a perpetuation of sin. Extinct.

Abrahamites.— An obscure Bohemian sect of deists. Its members rejected all distinctively Christian doctrine, with the exception of the Lord's Prayer, which they used, adopting the tenets of the religion of Abraham as contained in the Decalogue. Extinct.

Abyssinian Church.— That branch of the Christian Church that has been established in Abyssinia for many centuries. It is in agreement with the Coptic Church concerning its ritual and practice, but differs from it slightly in its theological position.

Acacians.— An Arian sect which occupied a theological position half way between the Semi-Arian and the extreme Arian, or Anomœan sects. Extinct.

Adamites.— Several attempts have been made to revive the sect of Adamites, which was first suppressed in the 2d century. Its pretensions are that its members have attained the primitive purity of Adam and are, therefore, able to dispense with marriage and to go without clothing at their meetings, which are called "paradises." Upon each appearance it has been prescribed, the last attempt at rejuvenation having been in 1848–9.

Adelphians.— A branch of the Euchite sect. Extinct.

Admonitionists.— The followers of Thomas Cartwright, who, in 1572, advocated the government of churches by presbyters instead of bishops and who urged the right of the church to hold supremacy over the state. Extinct.

Advent Christian.— The largest branch of Adventists. Absolutely millennial in character, it teaches the final extinction of all evil as well as the renewal of the earth that it may become the future abode of the saints. (See Adventists.)

Aerians.— A reforming sect in the 4th century now sometimes considered to have been a forerunner of modern Presbyterianism. The members declined to permit prayers for the dead, repudiated the church fasts, and made the authority of the presbyters equal to that of the bishops. Extinct.

Age-to-Come Adventists.— One of the many sects of Adventists. Its members believe that at the time of the millennium Christ will assume a personal rather than a spiritual rule over the earth which, they hold, will not be destroyed at the Second Coming. (See Adventists.)

Agnostics.— While unorganized as a sect agnosticism teaches the theory that it is impossible for man to attain to any definite knowledge of the divine power.

Aitkenites.— A party which was founded in the Church of England about the year 1850, by Robert Aitkens, a ritualistic clergyman. It was an attempt to graft a portion of the tenets of Methodism upon the High Church school of ritualistic and sacerdotal theology.

Albaneses.— A mediæval sect closely allied to the Albigenses. Extinct.

Albigenses.— A name applied to the anti-sacerdotal sects that revolted from the Church of Rome during the 12th century. They were vigorously persecuted and finally exterminated.

Allenites.— The followers of Henry Allen, who preached the peculiar doctrine that all souls were actually present at the Garden of Eden where they participated in the fall of Adam. Extinct.

Alogians.— A name applied to a heretical sect of the 2d century because of its rejection of the doctrine of the Logos and the Gospel of Saint John.

Amalricianism.— A pantheistic heresy promulgated by Amalric of Bène, professor of logic and exegesis in the University of Paris. Extinct.

Amyraldists.— A sect of Calvinists who followed Moses Amyraut in his attempt to reconcile the disputes concerning predestination and divine grace.

Anabaptists.— A name most generally applied to those bodies of extreme anti-sacerdotalists which required re-baptism from those who had been baptized in infancy and who were often over-zealous in their repudiation of certain doctrines of the 16th century Church. For many years the term was seldom used except as one of opprobrium.

Angel Dancers.—A small sect of vegetarians founded about 1890 by Huntsman T. Mason, who claimed to be the reincarnation of the spirit of Saint John the Baptist.

Angelic Brothers.— A community of Dutch pietists founded by George Gichtel in the 16th century. Its members held that, having attained a state of angelic purity, they should give no further thought to marriage. Extinct.

Anglicans.— One definition for the High Church school in the Episcopal Church.

Annihilationists.— The name applied to those sects which teach the absolute destruction of the wicked.

Anomœans.—The extreme sect of Arians, it taught that the Son was of an essence which was not even similar to that of the Father. It existed during the 4th century.

Ansarians.—A sect whose membership is almost entirely restricted to a small district in Syria. As a religious belief it is a combination of Mohammedanism, paganism and something that somewhat resembles Christianity. This strange faith is said to have first been taught by Nusari, a prophet and saint who lived at Nasai, near Koufa, in the latter part of the 9th century, and his gospel included the doctrine of metempsychosis as well as that of divine unity in three personalities, the second and third being created. This sect now receives both the Old and New Testaments, the Koran, and several apocryphal works as its inspired scriptures.

Antiburghers.— A name applied to one of the two factions into which the Scottish Secession Church was split in 1747. The controversy was based upon the lawfulness of a clause in the oath required to be taken by burgesses, but, while the point was fiercely contended for several years, the two factions were reunited in 1820.

Anti-Mission Baptists.— A sect which is theologically in accord with the regular Baptists but that is opposed to missions, Sunday schools, and other educational and evangelistic enterprises.

Anti-pædobaptists.—A name sometimes applied to sects that are opposed to the doctrine of infant baptism.

Aphthartodocetæ.—A sect which became extinct about the 9th century. It held that the body of Christ was incorruptible even before the resurrection and that his suffering of death was merely a phantasma.

Apollinarians.— A sect condemned during the 4th century for having denied the proper humility of Christ.

Arians.—The followers of Arius, the Alexandrian priest who promulgated a widespread heresy during the 4th century. Denying the divinity of Christ and other fundamental doctrines of the Christian Church, he was condemned and Arianism was suppressed by order of the early councils. Since that time, however, the doctrines taught by Arius have been frequently revived and they still exist under other designations.

Armenians.— Although the separation of the Armenian Church from the main body of Christians, which occurred at the time of the Council of Chalcedon (451 A.D.), was the result of a comparatively inconsequential misunderstanding, it has been maintained to this day, in spite of the several attempts at reconciliation.

Arminians.— A name sometimes applied to the anti-Calvinistic sects of Protestants which teach the doctrine of universal salvation.

Artotyrites.— A sect existing in the early days of the Church. It admitted women both to the priesthood and the episcopate and taught the use of bread and cheese in the eucharist on the ground that it was right that man's oblations should be of the fruits of the earth and of the flocks.

Atheists.— The term applied to those persons who deny the existence of God.

Baanites.— A Paulician sect of the 8th and 9th centuries. Extinct.

Babists.—The followers of Mirza Ali Muhammad of Shiraz, who founded a new religious system in Persia during 1844. Described as a "Pantheistic offshoot from Mohammedanism, tinctured with Gnostic, Jewish, and Buddhistic ideas," the high form of morality which it teaches has appealed so strongly to the Western mind that its converts in America alone during the past few years undoubtedly number several thousand. Among other doctrines Babism teaches the equality of the sexes.

Baptists.—Those sects which oppose infant baptism, administering the rite only to adult persons, and then baptizing them not to make them children of God, but as a sign that they themselves have accepted Him. (See Baptists, and Baptists in America.)

Beguni.— A fanatical Russian sect which preaches and, it is feared, sometimes practises the rite of human sacrifice as a means of justification before God.

Bezopoftschins.— Many sects of Russian dissenters depend upon an independent ministry, rejecting the office of priest, or "pope." They are designated as Bezopoftschins.

Bible Christians.— See BRYANITES below.

Bohemian Brethren.— A Hussite sect which was quite numerous in Bohemia but which ceased to exist at the end of the 17th century.

Booldo.— The Buddhism of Korea, which differs but slightly from that of China.

Borrelists.— A sect of Mennonites whose worship is devoid of all external ordinances.

Bourignonists.—A sect of Quietists founded by Antoinette Bourignon, a pietist who claimed to be the subject of divine inspiration, in the 17th century. Extinct.

Brahmanism, or *Hinduism.*—This religion, which is the oldest faith that has sprung from the Aryan family, derives its name from that of its chief caste, from which alone, the priests are selected.

Brahmo-Somaj.—A monotheistic Hindu sect which apparently owes its origin to the contact of Brahmanism with the various anti-sacerdotal forms of Christianity represented by the missionaries.

Broad Churchmen.— A designation often applied to a school of thought in the Protestant Episcopal Church, the members of which are inclined to give considerable latitude to individual opinion in the rejection or acceptance of beliefs.

Bryanites.— Otherwise known as "Bible Christians." A sect which is in general theological accord with Methodism, but which permits women to preach.

Buchanites.— The followers of Elspeth Buchan, or Simpson, a religious enthusiast in Scotland who claimed to be the woman of Revelation in whom the light of God was restored to men. Extinct.

Buddhism.— The reform movement which originated in India, some 2,500 years ago. It was a protest against the religious and social despotism of Brahmanism, and, while atheistic in theory, teaching that release from existence, or absorption into the infinite, is the great good to which man should look forward, it has exercised an elevating effect upon the social and moral conditions of the countries where it has been accepted. It is still the religious faith of about one third of the human race.

Cainites.— A fanatical Gnostic sect of the 2d century. Its members reverenced such personages as Cain, Esau, and Judas Iscariot. Extinct.

Calendar Brethren.— A religious society, which, while once prominent, now exists only in Brunswick. It derives its name from the fact that its meetings are always held on the Kalends, or the first day of the month.

Calvinists.— A designation applied to those Christians, in various sects, who follow John Calvin in his opinions regarding the ministry, the sacraments, and divine grace, as exploited in his doctrines of "Election" and "Particular Redemption."

Campbellites.— The followers of Rev. John McLeod Campbell, who taught the universality of the atonement and who held that Christ's death was in no sense a vicarious satisfaction of divine justice. He was condemned as a heretic by the Presbytery of Dumbarton in 1830.

Campbellites, American.— Otherwise known as Disciples of Christ, or as Reformed Baptists. A Baptist sect founded by Rev. Thomas Campbell: Congregational in discipline it insists upon baptism by immersion as the requirement for admission to its membership. (See CHRIST, DISCIPLES OF.)

Catholic Apostolic Church.— See IRVINGITES.

Christadelphians.— Otherwise known as Christ's Brethren. A sect of modern origin which has assumed its name to distinguish it from other bodies of Christians whom it regards as apostates. Quite similar to Unitarianism in its doctrines it still insists upon baptism by immersion. (See CHRISTADELPHIANS.)

Christian Catholic Church.— (See DOWIE.)

Christian Connection.—A sect which accepts no earthly leaders and which denies the inspiration of all creeds. Its members are permitted to be guided entirely by individual interpretation of the Holy Bible.

Christian Israelites.—A small sect, the members of which are anticipating the immediate second-coming of Christ.

Christian Scientists.— The followers of Mrs. Mary Baker Eddy, who, about 1866, promulgated a system of theosophic and therapeutic doctrine. Mrs. Eddy, in her book, "Science and Health," based her theories upon the Bible, teaching that as man's essential nature is spiritual and the Spirit of God, Love and Good, any moral and physical evil must be contrary to that Spirit, representing the absence of the True Spirit which was in Jesus Christ. (See CHRISTIAN SCIENCE.)

Christian Union.— A denomination recently organized at Columbus, Ohio. Its members hope to reunite all Christian bodies on the basis of the Bible.

Christians.— Several small sects have from time to time assumed the title "Christians," to indicate that they alone are possessed of true Christianity.

Christ's Brethren.—(See CHRISTADELPHIANS.)

Christ's Sacrum.— A religious society founded in the 18th century to work for the reunion of all Christian bodies. Practically extinct.

Church of God.— Otherwise known as Winebrennarians. A small body of Baptist Christians, which accepts no authority, or creed, except that contained in the doctrines exploited by its founder, John Winebrennan. (See CHURCH OF GOD.)

Church of God in Jesus Christ.—(See ADVENTISTS.)

Church of the New Jerusalem.— (See SWEDENBORGIANS.)

Coglers.— A sect of total abstainers whose chief tenet is that its members are morally incapable of committing any sin.

Collegiants.—A sect which, founded in the 17th century, is still well represented in The Netherlands and in some parts of Germany, deriving its name from the fact that its assemblies are known as colleges. Its theological position is practically that of the Quakers, plus baptism by immersion.

Collegiate Church.— The corporate name of a branch of the Reformed (Dutch) Church which occupies an important position among the religious bodies of New York.

Confucianism.— Although one of the popular religions of China, Confucianism is in no sense a religious system, its only worship being what may be defined as a religious veneration of ancestors. Instead of doctrines it presents instructions as to the proper mode of life, the discrimination between virtue and vice; the duty of compliance with the law of following the dictates of the conscience, etc.

Congregationalists.— An evangelical sect which derives its name from its fundamental principle in discipline, that each particular congregation is an independent body, having the right to elect or depose its pastors, settle all disputes regarding matters of faith, and exercise necessary discipline over its members without the interference of other congregations.

Copts.— The name applied to the Jacobite Church in Egypt, which has now almost entirely supplanted the Orthodox Church.

Cumberland Presbyterians.— A sect which withdrew from the Presbyterian Church in 1810 because of the refusal of that body to recognize as ministers persons who had been admitted without the usual educational preparation and who refused to subscribe to the Calvinistic doctrine of "Election." (See PRESBYTERIAN CHURCH.)

Deists.— Those who believe in the existence of God, but who accept few if any other of the doctrines of the Christian religion.

Devil Worshippers.—(See SATANISTS and YEZEEDEES.)

Donatists.— An early Christian sect in Africa. Its members held that they alone constituted the true church and that any offices performed by other clergy were invalid. Extinct.

Dowieites.— Otherwise known as "The Christian Catholic Church." A sect primitive in creed, the members of which believe in the healing of disease by prayer. It was founded about 1892 by John Alexander Dowie, the present General Overseer, who professes to be the reincarnation of the Prophet Elijah.

Druses.— A fanatical sect found chiefly in the mountainous regions of Syria. Their name is derived from that of their first apostle, Ismail Darazi, or Durzi. Little is known concerning their belief, their reputation for fanaticism being based upon the blood feud which they have long maintained against their Maronite neighbors.

Dukhobortsi.—A Russian sect which originated in the early part of the 18th century. It has been subjected to repeated persecutions both because of its religious doctrines and for the refusal of its members to abide by the laws of the country.

Dunkards.— Otherwise known as Brethren. An American sect of extremely primitive Baptists which was founded by a party of German emigrants in the 18th century. In addition to a dress which is peculiar to themselves, its members maintain such customs as the washing of feet and the anointing of the sick with oil. (See DUNKARDS.)

Ebionites.— A sect of Judaizing Christians which became extinct about the 4th century. They recognized Christ as the Messiah, but denied his divinity and repudiated the writings of the apostles, accepting the Mosaic law.

Elcesaites.— A Jewish Christian sect very similar in doctrine and practice to the Ebionites. Extinct.

Encratites.— The name applied to those members of the early Church who refrained from marriage as well as the use of wine and flesh meat. Extinct.

Enochites.— A millenarian sect in Russia. It teaches that the Prophet Enoch has already returned to earth and that his personal manifestation will be the signal for the destruction of all matter.

Ensarians.— See ANSARIANS.

Erastians.— The followers of Thomas Erastus, who proposed several restrictions regarding the jurisdiction of the Church. Extinct.

Euchites.— A 4th century sect sometimes known as Euthusiasts. Its members lived a life of prayer and asceticism and repudiated the sacraments and moral law. Extinct.

Eunomians.— A sect of extreme Arians. Extinct.

Eusebians.— The followers of Eusebius of Nicomedia, who effected the restoration of Arius in 334. Extinct.

Eustathians.— The orthodox sect in Antioch during the 4th century. Extinct.

Eutychians.— The members of a sect condemned for heresy in the 5th century. They taught that Christ was possessed only of a divine nature. Extinct.

Evangelical Adventists.— The original sects of Adventism. Its particular belief is in the conscious state of the dead and, necessarily, the conscious suffering of the wicked. Like other Advent sects it is millenarian. (See ADVENTISTS.)

Evangelical Association.— A sect whose belief is like that of the Methodists except that it rejects the doctrine of original sin. (See EVANGELICAL ASSOCIATION.)

Evangelicals.— A designation sometimes applied to the Low Church party in the Episcopal Church.

Fetishism.—The lowest grade of idolatry, taking the form of a worship of some material object to which a supernatural power is ascribed.

Fire Worshippers.— A designation by which the Parsees are sometimes known.

Flagellants.— The victims of a hysterical mania which spread over almost every portion of Europe during the Middle Ages. Its devotees held that in flagellation was the only means to salvation, but their use of the scourge was finally suppressed by the ecclesiastical powers.

Flemings.— Otherwise known as "Fine," or rigid Mennonites, because they profess to maintain more ancient rites and stricter principles than those followed by ordinary Mennonites. Among these ancient rites is that of feet washing.

Foism.— The official name for the Buddhism of China. Its worship includes that of many gods which are peculiar to itself.

Fratricelli.— A sect which had its origin in a reformation of the Franciscan order in the 13th century. Its members devoted themselves to prayer, rejected the sacraments, and held that the ideal Christian condition was one of poverty. Extinct.

Free Church of England.— A name which has been assumed at various times by sects which have seceded from the Church of England. They have had no affiliation, however, either in principles of practice.

Free Kirk of Scotland.— A name assumed by that body of Presbyterians which seceded from the Established Church of Scotland in 1843. The only points in which it differs from the older body are in matters of patronage and the question of the right of the state to interfere in church affairs.

Free Will Baptists.— A sect which withdrew from the Baptist communion in 1780, chiefly because of its rejection of the Calvinistic doctrine of election.

Friends of Light.— A sect of Rationalistic Lutherans. It taught that complete intellectual freedom in religious belief could not be obtained except when individual judgment was permitted to be the sole guide of the conscience.

Friends, Society of.— (See QUAKERS.)

Galenists.— A Mennonite sect founded in 1664 as the Arminian branch of the Waterlands.

Glassites.—(See SANDERMANIANS.)

Gnostics.— The name applied to the Rationalistic sects which flourished between the 2d and the 6th centuries. They rejected the literal translation of the Scriptures, held that God was unknowable, that Christ was a superior æon who had come to subdue the æon of this world, and insisted that knowledge instead of faith was necessary to salvation. Extinct.

Greek Orthodox Church.— The name applied to the communion which since its separation from Rome, has acknowledged the primacy of the Patriarch of Constantinople.

Gymnosophists.— An ascetical sect of Hindu philosophers who lived as hermits that they might better devote themselves to silent contemplation. Extinct.

Hanafites.— The oldest of the four orthodox sects of Sunnite Mohammedans.

Harmony Society.— A communistic religious body composed of members of the German Pietist sect, the Separatists, which emigrated to the United States in 1803 and founded a colony in Pennsylvania, the model for which was the primitive church. After removing to Indiana in 1815, they returned to Pennsylvania in 1825, when they founded the township of Economy and the new village of Harmony. Communistic in character, they hold all property in common, discourage matrimony, and look for the early second-coming of Christ.

Hattemists.— A sect founded in The Netherlands in the 17th century. Its members denied the expiatory sacrifice of Christ and held that sin can exist only in the imagination. Extinct.

Henricians.— A sect of religious reformers that originated in Switzerland during the 12th century. Extinct.

Heracleonites.— A Gnostic sect of the 2d century. Extinct.

Hicksites.— Those who followed Elias Hicks in his separation from the main body of the Society of Friends in 1827. They deny the divinity of Christ and repudiate the doctrines of the Atonement and the Trinity.

High Churchmen.— Otherwise known as Ritualists. A designation applied to those members of the Episcopal Church who exalt the authority of the Church and give prominence to the sacerdotal aspect of the priestly office.

Hinduism.— The name applied to the modern religious beliefs which have developed from Brahmanism.

Holy Ghost and Us, Society of the.— Otherwise known as "The Church of the Living God." A sect which, millennial in character, teaches the cure of disease by faith and professes to follow a literal interpretation of the Scriptures.

Holy Rollers.— A designation applied to a small sect because of the peculiar habits of its members who roll upon the ground during their religious ecstasies.

House of Israel.— An obscure sect of American millenarians.

Huntingdonians.— A sect of Calvinistic Methodists, congregational in policy, which was founded by Selina, Countess of Huntington, after her withdrawal from the Wesleyan communion.

Huntingtonians.— A sect founded by William Huntington, known as the "preaching coal-heaver," who laid great stress upon the doctrines of faith and indefectible grace. Practically extinct.

Hutchinsonians, English.— The followers of John Hutchinson, who, accepting the Bible as the source of all science and all philosophy, opposed the system of Newton and all other scientific theories that could not easily be reconciled with their belief. Extinct.

Hutchinsonians, American.— The followers of Mrs. Anne Hutchinson, who taught the Antinomian doctrines in the Massachusetts Colony soon after its foundation. Extinct.

Independent Methodists.— A title assumed by several independent congregations of Calvinistic Methodists.

Inghamites.— A religious denomination founded in England in the 18th century by Benjamin Ingham, who taught a peculiar combination of Methodism and Moravianism. Extinct.

Irvingites.— Otherwise known as "The Catholic and Apostolic Church." A sect founded in 1831, its doctrines being based upon the teachings of Edward Irving, who held that by a new "outpouring" of God through the Holy Ghost the prophetic and apostolic offices had been re-established. Its ritual is very elaborate.

Jacobites.—A sect of Christians in Asia, the members of which have remained true to the Monophysite doctrines. Its churches include three patriarchates, those of Antioch, Armenia, and Alexandria.

Jains.—A non-conformist Hindu sect, the members of which believe that every object in the world, including plants and minerals, as well as men and animals, possesses souls.

Jansenists.— A school of thought established in the Roman Catholic Church by Cornelius Jansen during the 17th century. It has frequently been the subject of the condemnation of the ecclesiastical authorities.

Jerkers.— A name, usually a term of opprobrium applied to those sects whose members are in the habit of indulging in violent exhibitions of religious fervor on the occasion of revivals or other special meetings.

Joachimites.— A mystical sect which existed until some time in the 13th century. Its members believed that the earth was passing through the third and last period of its existence and that a new gospel would soon appear to supersede the Old and New Testaments.

Julianists.— A sect in the 6th century. It held that the body of Christ was incorruptible. Extinct.

Jumpers.— A name which was first applied to the Methodists of Wales because of their peculiar actions during times of religious frenzy.

Kabbalists.—Those who are devoted to the Kabbala, or the theosophical or mystical philosophy of the Hebrew faith.

Kabirpanthis.— The followers of Kabir, a Hindu reformer, who denounced idol worship and preached that the only religion was devotion to one god, irrespective of the name by which that god might be known.

Karaites.— Otherwise known as "The Karim," or "Scripturists." A Jewish sect which adheres strictly to the Scriptures, rejecting the authority of the Kabbala as well as the Talmuds.

Kilhamites.— A name often applied to the followers of Alexander Kilham, the founder of the "New Connection of Wesleyan Methodists."

Labadists.— A sect of Christian communists which existed until the middle of the 18th century. Its members upheld the doctrines of Jean de Labadie, who taught that as life was a perpetual sabbath, the observance of a particular day was unnecessary and that marriage as a holy ordinance was not valid unless both parties to it were believers, in which case the children of such unions were born without the taint of original sin.

Lamaism.— The Buddhism of Tibet, which teaches that the soul of Buddha is always present, reincarnate in the body of the Grand Lama.

Latter Day Saints.— (See MORMONS.)

Leonists.— Same as Waldenses.

Lesghians.— A Mohammedan sect living in the Caucasus.

Life and Advent Union.— A sect which is similar to regular Adventism except that it holds that the souls of the wicked are exterminated and will not be present with the saints at the day of resurrection. (See ADVENTISTS.)

Lollards.— Otherwise known as "Bible men." The followers of Wyclif in England during the 14th century. Extinct.

Low Churchmen.— The designation applied to that branch of the Episcopal Church, the members of which strive to avoid anything savoring of sacerdotalism and whose chief regard for the ministry and the sacraments is based upon their relation to the religious life of mankind.

Lucianists.— The members of a Marcionite sect which existed during the 2d century. They held that while some representation of the soul and body would appear at the resurrection, the actual soul and body would not participate in that event. Extinct.

Lutherans.— Although there have been many changes in the various branches of the Lutheran Church since the days of Luther the doctrines which he promulgated in the 16th century are the basis for the beliefs of all the sects which bear his name and which are now represented in almost every part of the Old and New Worlds. The title is also applied to all followers of that 16th century reform movement which cost the Roman Catholic Church so large a part of the Teutonic and Scandinavian constituency. (See LUTHERAN CHURCH IN AMERICA.)

Macarians.— A monothelitic sect founded by Macarius, patriarch of Antioch, in the 7th century. Extinct.

Macedonians.— A sect founded by Macedonius, bishop of Constantinople, in the 4th century. Its members denied the Godhead or distinct existence of the Holy Spirit, claiming that the supposed third person in the Trinity was no more than a divine energy which God had diffused through the universe. Extinct.

Malakanes.— A millenarian sect in Russia, the members of which reject all sacraments.

Mandæans.— An Eastern sect that has never extended beyond Persia and Arabia. Its members are known as "Disciples of Saint John the Baptist," and, from the Christian point of view, their Christology is of a most heretical character.

Marcellians.— Followers of Marcellus, bishop of Ancyra, in the 4th century. They held that the Holy Spirit was merely an impersonal agency of God. Extinct.

Marcellinists.— A Gnostic sect of the 2d century. Extinct.

Marcionites.— An ascetic Gnostic sect of the 2d century. Its members rejected the Old Testament and denied both the incarnation and the resurrection. Extinct.

Maronites.— The ecclesiastical name for a Syrian tribe inhabiting the slopes of Lebanon. In the early days the Maronites followed the monothelite heresy, but, in 1445, they were reunited to the Roman communion, although they have continued to retain their own liturgical customs, just as they elect their own patriarch.

Martinists.— A school of religionists, or kind of pietist freemasonry, instituted by Chevalier Saint Martin. Among other peculiar doctrines the founder taught that man is antecedent to nature, having existed in spirit, of the same essence as God Himself, prior to his existence in body.

Massilians.— The members of a Semi-Pelagian school once numerous in France.

Materialists.— Those who hold that matter is the first and only principle and that mind is the derived result.

Melchites.— The name by which the orthodox Egyptians are distinguished from the Jacobites.

Meletians.— A 4th century sect, followers of Meletius, a schismatic Egyptian bishop. Extinct.

Men, The.— The name applied to a class of lay preachers who frequent the Scottish Highlands. They wear a distinctive dress and are in direct opposition to the Kirk in all their ministrations.

Mennonites.— A general designation for those sects which were known as Anabaptists until the time of their reformation by Menno, in the 16th century. (See MENNONITES.)

Methodists.— A general designation for those sects which are more or less the outcome of the institution of John Wesley's confraternity, in 1739. The parent sect was known as Wesleyan Methodists, but many other important branches have been organized since that time, including the Methodist Episcopal Church, Methodist Reformed Church, Methodist Protestant Church, Union American Methodist Episcopal Church, Methodist Episcopal Church South, Congregational Methodist Church, New Congregational Church, Primitive Methodist Church, Free Methodist Church, Independent Methodist Church, Methodist Connection, and various African and Zion Methodist branches, which are composed of colored persons. (See METHODISM IN AMERICA.)

Michaelhahnites.—A pietist and millenarian sect organized by Michael Hahn after his separation from the Evangelical Lutheran Church of Würtemberg. Extinct.

Millenarians.— A general designation for those Christians who anticipate the early second-coming of Christ. There are many bodies of millenarians, all professing different doctrines, the more extreme asserting that the dead will finally be restored to life, including all its bodily pleasures, on earth.

Mohammedans.— The followers of the Prophet Mohammed, who began to propagate his faith in Arabia in 611. The name which was given to this religion by its founder was "Islam," one meaning of which is "to submit wholly to God and to acknowledge Him only as Lord." The entire Mohammedan faith may be briefly explained by reference to its two articles: (1) "There is no God but God," and (2) "Mohammed is His Prophet," a proposition the acceptance of which makes every doctrine of divine authority.

Molinists.— There have been two sects which have borne the name of Molinists: (1) Those who agreed with Luis Molina regarding the doctrines of free will and predestination, and (2) the followers of Miguel Molinos, the Spanish mystic who taught the doctrine of the direct relationship between the soul and God. The latter were also known as Quietists. Both are extinct.

Monarchians.— A designation applied to those who deny the distinction of persons in the Trinity.

Montanists.— A 2d century sect, the followers of which believed in the divine and prophetic inspiration of Montanus of Phrygia. Extinct.

Moravians.— Otherwise known as Moravian Brethren. A sect which occupies a theological position which is almost identically that of the Evangelical Lutheran Church. Formerly affiliated with the Taborites, it withdrew from that communion during the 15th century.

Morelstschiki.— A fanatical Russian sect whose practices are said to be in keeping with its name, which means "self-immolators."

Mormons.— Otherwise known as Latter Day Saints. A religious system organized by Joseph Smith, who claimed to have found his inspiration in a "Book of Mormon," which he had unearthed and translated The doctrines have been further extended by later revelations, one of which, the "Celestial Law of Marriage," which was promulgated in 1852, and which authorized the practice of polygamy, having resulted in a reform movement which brought about the secession of a large body of Mormons who assumed the name of the "Reorganized Church of Jesus Christ of Latter Day Saints." (See MORMONS.)

Muggletonians.— An English sect founded in 1651 by Lodowick Muggleton and John Reeve, who claimed to be the two witnesses referred to in Revelations. They insisted that they were divinely inspired and taught many doctrines peculiar to themselves. Extinct.

Mystics.— The general designation applied to those who believe that a rapt soul may enter into union with the divine by means of ecstatic contemplation.

Naumbergers.— An obscure evangelical sect which carries the simplicity of its dress to such extreme as to use hooks and eyes instead of buttons.

Nazarenes.—A 4th century sect of Jewish Christians. While observing the Mosaic ritual they accepted the divinity of Christ and looked for his early second-coming.

Necessitarians.— A general designation applied to those who believe that a fixed and unchangeable law governs everything.

Nestorians.— The followers of Nestorius, who denied the hypostatic union of the two natures in the one person, Christ. Two sects of Nestorians, the remnants of the once-powerful denomination, still exist, one in Turkey and Persia, and the other in India.

Netovtschins.— A sect of Russian dissenters who believe that antichrist has commenced the ruin of the Church and that all holiness is gradually being extinguished.

New Jerusalem Church.— (See Swedenborgianism.)

New Lights.— A designation sometimes applied to the Free Will Baptists and Separatists.

Niobites.— A monophysite sect which was finally absorbed into the orthodox communion. Its members held that the human nature of Christ was lost in its union with his divine nature.

Non-conformists.—A designation sometimes applied to various sects of Protestant dissenters.

Noetians.— The followers of Noetus, a 2d century heretic, who held that Christ was the actual embodiment of the Father and that it was the Father Himself who was born and had suffered death on the cross.

Novations.— An austere 3d century sect which was absorbed by the mother church before the 6th century, its differences having been chiefly in regard to matters of church discipline.

Oahspe.— A sect of American vegetarians, extremely primitive in character. Its tenets prohibit divorce and second marriage and its members are not permitted to have recourse to law.

Old Catholic.— A movement inaugurated in Germany as a protest against certain dogmas of the Roman Catholic Church.

Old Lutherans.— The name applied to those Lutherans of Prussia who have refused to enter into affiliation with the United Evangelical Church.

Old School Baptists.— The name assumed by a religious sect which still maintains the strict doctrines of Calvinism.

Old Two-Seed-in-the-Spirit Predestinarians.—A strictly Calvinistic sect of American Baptists.

Omish Church.— The name applied to a strict sect of primitive Mennonites.

Ophites.— A Gnostic sect which held that the serpent that tempted Eve was the impersonation of divine wisdom.

Osiandrians.— The followers of Osiander, a 16th century theologian who taught that the attainment of the essential righteousness of Christ was necessary to justification by faith.

Pantheists.— The members of a philosophical school which teaches that God is in everything and that everything is God.

Parsees, or *Parsis.*— The followers of Zoroaster, who founded the ancient religion of Media and Persia, about 1000 B.C.

Paulicians.— A sect founded in the 7th century, the members of which held that all matter is evil and that Christ had a purely ethereal body and suffered only in appearance. Extinct.

Peculiar People.— A sect which in almost every respect resembles the Dunkards.

Pelagians.— A sect which held that there was no original sin, but that each soul was created sinless and free. Extinct.

Peremayanoftschins.— A sect of Russian dissenters which requires the re-ordination of the clergy.

Perfectibilists.—A name applied to those who hold that absolute perfection is attainable during the present life.

Perfectionists.— The name assumed by an American sect established by John Humphrey Noyes, in 1845. In addition to teaching perfect holiness through complete reconciliation with God, its founder maintained the equality of the sexes and the community of goods.

Picards.— A sect suppressed in the 15th century because of alleged immoralities. They held that salvation was obtainable only through the restoration of man's primitive innocence.

Pietists.— A general designation applied to those who claim to be possessed of extreme piety.

Plymouth Brethren.— A sect which holds the two doctrines of Predestinarianism and Millenarianism and which does not maintain a separate ministry.

Pomorane.—A sect of Russian dissenters which has no separate ministry and which requires re-baptism of converts.

Popoftschins.— That branch of Russian dissenters which continues to maintain the office of priest, or "pope."

Positivism.—A modern school of skepticism, founded by Auguste Comte. As a religion Positivism is nothing less than the worship of humanity; as a philosophy, it teaches that nothing should be accepted as true unless it can be positively demonstrated.

Predestinarians.— A general designation applied to those who believe that each soul is predestined for heaven or hell from all eternity.

Presbyterians.— The name assumed by a denomination which maintains that the ministry of the Church should consist of but one order, that of presbyters, or elders. Its creed, which has been Calvinistic since the establishment of the denomination, is now, in some places, in process of alteration.

Princeites.— A small English sect established in 1840 by Henry James Prince, who professed that his person represented a new dispensation of the Holy Ghost by which the dispensation of Christ was to be superseded. It is now practically extinct.

Protestant Episcopal Church.— The American representative of the Church of England, the denomination which led in the protesting reformation of the Roman Catholic Church in that country. In addition to its creeds it adopts the principles of the Thirty-nine Articles and makes use of the Book of Common Prayer. (See Protestant Episcopal Church.)

Puseyites.— The name sometimes applied to the High Church school in the Episcopal Church, from that of Dr. Pusey, who was one of the leaders in the "Tractarian" or ritualistic movement.

Pyrrhonists.— The designation applied to that school of extreme skepticism which denies the possibility of attaining with certainty any absolute truth.

Quakers.— Otherwise known as Friends, or as the Society of Friends. A sect founded by George Fox. Its members reject all sacraments, possess a mixed but not settled ministry which depends upon the inspiration of the Holy Spirit for its utterances, and refuse to participate in wars or to take oaths. They also maintain a peculiarity of dress and a simplicity of speech which is quite in keeping with their life of peace and meditation. (See Friends, Society of.)

Quietists.— A designation often applied to a school of mysticism, the followers of which profess to resign themselves passively to what they regard as divine manifestations. The name is also applied to certain distinctive sects like the Bourignonists and Molinists.

Rappists.—(See Harmony Society.)

Rationalists.— Those who maintain that reason is the one test of truth in matters of religious faith and who are guided by this theory in their interpretations of the Bible.

Reformed Dutch Church.— The Reformed Protestant Dutch Church which was instituted in the Netherlands during the 16th century. In 1561 it adopted a confession of faith, known as the Belgic confession, which was prepared by Guido de Bres, who took for his model the Calvinistic confession of the Church of France. This body was the first Reformed Church instituted in the American colonies.

Reformed Dutch Church, True.— A sect resulting from the secession of a party led by Rev. Sol Froeligh, in 1822. They held that the Reformed Dutch Church had become erroneous in doctrine, lax in discipline and corrupt in practice. During recent years the sect has gradually dwindled away although it is still in existence.

Reformed Episcopal Church.— Founded in 1873 as a church of the reformation, or, as a protest against what it termed the errors in the position and practice of the Protestant Episcopal Church.

Reformed German Church.— That portion of the Protestant church which, being unable to embrace either the teaching of Luther or of Zwingli endorsed instead the Melanchthonian compromise.

Reformed Presbyterian Church.— Otherwise known as Cameronians. A sect founded in the 17th century as a protest against what its members regarded as the "unworthy compromise" of the Established Church.

Remonstrants.— A title applied to the Arminians for the reason that they had called their creed, adopted in 1610, "The Remonstrance."

Relief Synod.— A body of Scotch dissenters whose secession was the result of their opposition to the existing system of patronage.

Restorationists.— A small sect the beliefs of which may be designated as Universalism in a modified form.

Ritualists.— Another designation for High Churchmen.

Roman Catholic Church.— That body of Christians who look to the Holy See for direction in spiritual things. (See Roman Catholic Church.)

Russian Orthodox Church.— The national Church of Russia. It differs in belief but slightly from that of the Roman Catholic Church, from which it separated about 1,000 years ago.

Ruthenians.— The members of the Ruthenian Church are converts and the descendants of converts from the Russian Church who now maintain obedience to the Pope in spite of the fact that they have never altered their ancient rites and discipline and still use the Greek liturgy, which they have translated into Old Slavonic.

Sabbatarians.— Those who insist upon the strict observance of the Sabbath as a tenet binding upon all Christians.

Sabbatians.— A 4th century sect the members of which adopted the Quartodeciman rule. Extinct.

Salvation Army.— A quasi-military organization formed to promote the revival of religion among the masses. It was organized in England, about 1865, by William Booth, a Methodist evangelist. At that time it was known as the Christian Mission, and it retained the title until 1878, when it was changed to that of the Salvation Army. Its theological position is thoroughly evangelical.

Samokrischtchins.—A name which signifies "self-baptizers," and which as applied to a sect of Russian Christians, indicates its theological peculiarity.

Sandemanians.— A denomination founded in the 17th century by Robert Sandeman, a disciple of John Glas. Its members maintain a community of goods; abstain from blood meats and from things strangled, and participate in love feasts and a weekly communion.

Satanists.— The members of a strange sect which worships and prays to Satan not only because of his present power to do evil, but on account of his future power to do good.

Schwenckfeldians.— A sect of German anti-sacramentalists founded at the time of the Reformation by Casper Schwenckfeld.

Scottish Baptists.— A sect which differs from other Baptists only by being more Congregational in government and having a somewhat stricter form in discipline.

Scottish Kirk.— The Established Presbyterian Church of Scotland, which, founded on the ruins of the ancient Scottish Church, in the 16th century was adopted as the National Establishment by act of Parliament.

Second Adventists.—(See ADVENTISM and MILLENARIANISM.)

Secularists.— The term Secularist is most generally applied to the members of that school of skepticism which holds that man should devote his attention only to the duties and interests of this world.

Seleucians.— Followers of Seleucus, who rejected baptism by water and who taught that there would be no resurrection of the body. Extinct.

Seventh-day Adventists.— The most primitive form of Adventism, its members practising many of the ancient Christian rites. (See ADVENTISM.)

Seventh-Day Baptists.— A sect which differs from other Baptists chiefly in the observance of Saturday, or the seventh day of the week, as its day for rest and worship.

Shafiities.— A Mohammedan sect, one of the four branches into which the orthodox sect of Sunnites has been divided.

Shakers.— A sect of American millenarians founded in 1776 by Ann Lee. Although it does not impose celibacy as a necessary rule of life, married couples are not permitted to live together in its communities.

Shaktas.— A Hindu sect, the members of which worship the divine power under its female representation.

Shiaha.— A Mohammedan sect which claims to be the one orthodox branch of the religion because they accept Ali, the first cousin of Mohammed, as the successor to the prophet, rejecting the other caliphs who are accepted by the Sunnites.

Shiites.— One of the two great divisions of Mohammedanism. Its doctrines are directly contrary to those of the orthodox sect, the Sunnites.

Shintoism.— The state religion of Japan. It teaches the existence of both good and evil gods.

Sikhs.— A sect founded in India, about 1500, upon principles of monotheism and human brotherhood.

Six-Principle Baptists.— The oldest sect of American Baptists. Its doctrines are founded upon the "six principles" mentioned in the first three verses of the sixth chapter of the Epistle to the Hebrews: (1) Repentance from dead works; (2) faith toward God; (3) baptism; (4) laying on of hands; (5) resurrection of the dead, and (6) eternal judgment.

Skoptsi.— A fanatical sect of Russians. Its members practise severe penances, including, it is said, self-mutilation.

Smartas.— One of the three great divisions of the Hindu religion.

Society of Friends.—(See FRIENDS, SOCIETY OF.)

Socinians.— The followers of Socinius, who denied the divinity of Christ and the atonement, who rejected the sacraments and the authority of the Scriptures, and who held that the soul of man was born pure.

Southcottians.— The followers of Joanna Southcott, who professed to be the inspired woman of Revelation, who was predestined to give birth to the new Messiah. Although she died of dropsy ten days after the date on which, as she had predicted, this event was to occur, her disciples maintained their faith in her supernatural gifts, and the sect still exists in small numbers in England.

Spiritualism.— A religious body composed of those who believe that it is possible for man to hold communication with the spirits of the departed.

Starovertzi.—A designation applied to those who refused to participate in the ecclesiastical reforms introduced in the Russian Church in the 17th century. The name signifies the "men of the ancient faith."

Sunnites.—The name applied to the orthodox Mohammedans who constitute the largest sect of the Moslem world. Its members accept the books of Sunna, said to be the verbal utterances of Mohammed, as well as the Koran, as the sources of doctrine. (See SUNNITES.)

Swedenborgians.— Otherwise known as the Church of the New Jerusalem. A religious system promulgated by Emmanuel Swedenborg, who taught that the last judgment had taken place in the year 1757, when the "Old Church," or Christianity had given place to the new dispensation as represented by the "New Church" of Swedenborg.

Syrian Church.— A religious body still under obedience to the Pope. Its members continue to maintain the ancient Syriac rites, which are common alike to the Jacobites and themselves.

Taborites.— The members of one of the most extreme parties of Hussites.

Taoism.— The materialistic religion of China.

Theists.— Believers in a personal Creator and Divinity, however conceived as related to man. The term is used as contrasted with Deists; Deism being the belief in a divine principle, not a personality.

Theosophists.— Those mystics who affirm that they are admitted to a knowledge of the mysteries of being, on the side of nature as well as upon that of religion, by means of an internal and supernatural illumination. One of the most modern applications of the word is as a designation for the followers of Mme. Blavatsky.

Traskites.— An early name for the Sabbatarian puritans.

Tübingen School.— A name applied to a certain rationalistic school of philosophy, the members of which questioned the credibility, integrity, and reliability of the New Testament.

Ultramontanists.— From a Roman Catholic point of view this name is applied to those who believe that the Pope is supreme ruler over every part of the Christian Church and of every sovereign of earth.

Unitarian.— A name applied to those who deny the distinction of persons in the Trinity and who hold that they in themselves only hold, in its true sense, the Unity of God.

United Brethren.— Otherwise known as United Brethren in Christ. A sect whose present doctrinal position is quite similar to that of the Moravians. Although never officially instituted it grew out of the attempt of William Otterbein to found a church that would unite the various Presbyterian sects as one body of Christians.

United Presbyterians.— A body composed of two sects of Scotch dissenters, the Associated and the Relief synods.

Universalists.— Those who believe in the ultimate salvation of all mankind.

Utilitarian.— A designation applied to those who hold that man's actions derive their character, in a moral sense, from their consequences.

Vamamargis.— The name applied to those persons who, in Hinduism, worship the female side of the dual nature of Vishnu.

Volunteers of America.— An offshoot from the Salvation Army resulting from a misunderstanding between the leaders of the two bodies. As in the Salvation Army both sexes participate in its meetings, and, like the older body, while it has no formulated creed, it is thoroughly evangelical.

Wahhabees.— Followers of Abd-el-Wahhab, a Mohammedan reformer of the 18th century. They strenuously oppose all practices not absolutely sanctioned by the Koran.

Waldensians.—A reforming body of Christians, the members of which participated in the Reformation. A Waldensian church now existent in Italy numbers more than 20,000 members.

Waterlanders.— A sect of Mennonites, similar in doctrine but less rigid in discipline than the main body.

Wilburites.— A branch of the Society of Friends who followed John Wilbur in his protests against the actions of the Society in abandoning its original principles.

Wilkinsonians.— A 19th century American sect the members of which accepted the statements of Jemima Wilkinson, who asserted that she was divinely inspired, having been raised from the dead.

Yezeedees.— An ancient sect of unknown origin. Its members form a tribe of individual nationality located in the neighborhood of Mosul. They not only believe in God but also in Satan, whom they recognize as the chief of the angelic hosts. Admitting that he is suffering punishment now, they believe that he will eventually be restored to his originally high station. As the result, like the Satanists, they believe that it is right for man to pray to him.

Zanzalians.— A designation applied to the Jacobites of the East.

Zoarites.— The name applied to a sect of American Lutherans.

Zoharites.— A modern Jewish sect which takes its name from the Kabbalistic book of Zohar, which is held in great veneration.

Zoroastrians.— See PARSEES.

J. R. MEADER,
Editor 'American Almanac.'

Religious Societies. See ORDERS, RELIGIOUS.

Rel'ly, James, Welsh Universalist clergyman: b. Jeffreston, Pembrokeshire, Wales, about 1722; d. London, England, 25 April 1778. He was converted by George Whitefield in 1741 and became one of his preachers, but after several years became convinced of the truth of Universalism and broke with Whitefield. He settled in London in 1761 and though his preaching met with little success yet in 1770 he converted to his faith John Murray (q.v.), the founder of Universalism in United States.

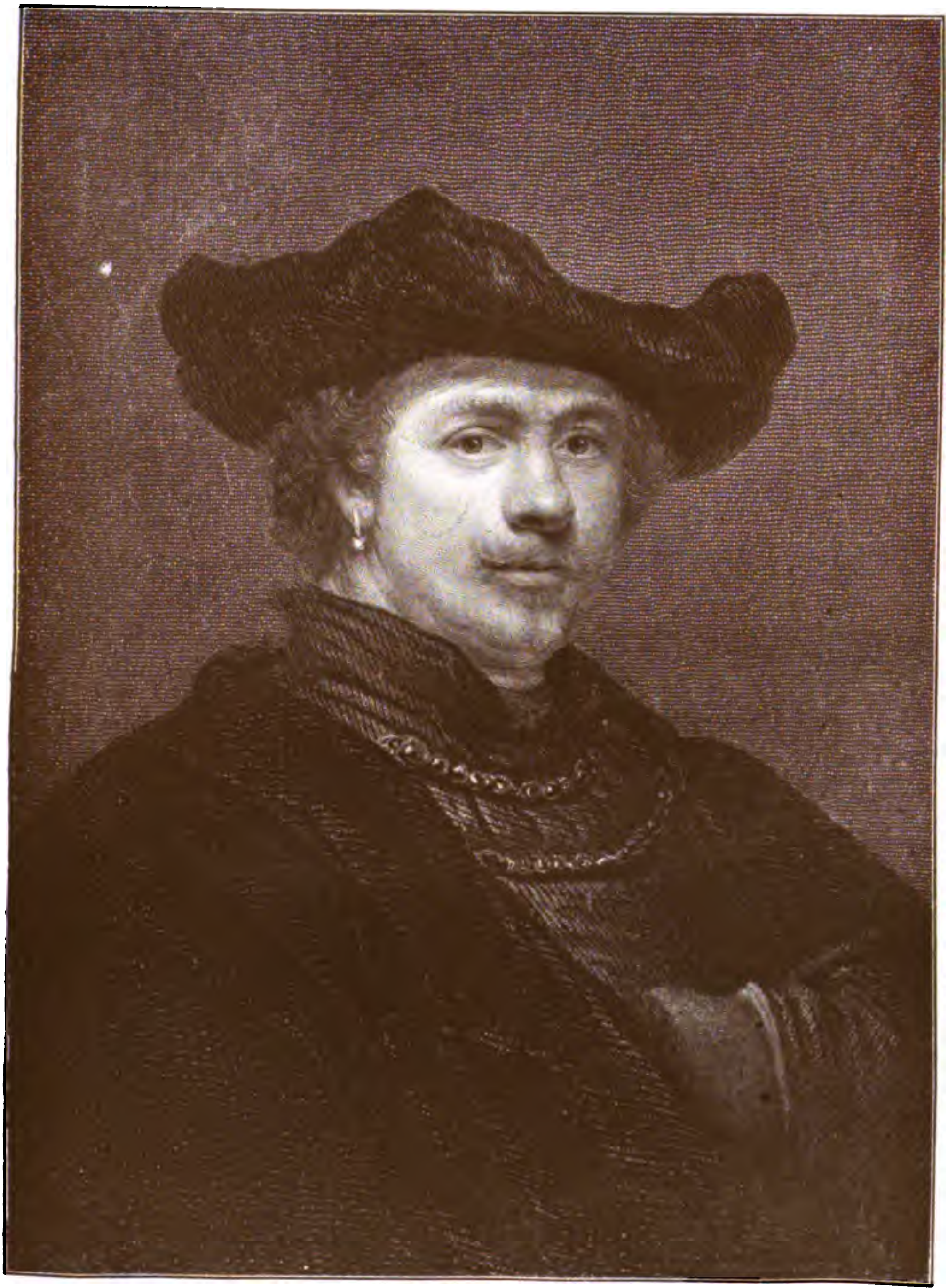
Remainder is defined in law as an estate which commences after the determination of another estate in the same property, which has previously been limited by the same conveyance. A remainder becomes vested whenever the preceding estate is limited so as to determine on an event which must certainly happen. It is the present right of one to the future enjoyment of an estate, which right takes effect on the determination of the preceding estate. Contingent estates usually give rise to considerable doubt. The intention expressed in the instrument by which the contingent estate is created, governs. Contingent remainders are defined by statute in some States.

Rembang, rĕm-băng', Java, a busy town on the north coast, west of the river Rembang, and 60 miles west-northwest of Samarang. Its well-protected harbor is one of the best in the island. It has a good trade in ship-timber and in ship-building, and near it are valuable salt-pans. Pop. 11,000.

Rembrandt, rĕm'brănt or -brănt (full name written REMBRANDT HARMENSZ VAN RIJN or RYN), Dutch painter and etcher: b. Leyden 15 July 1607; d. Amsterdam 8 Oct. 1669. He was the son of a miller settled in Leyden; and an early shown disposition toward the life of an artist caused him to be taken from the Latin School at an early age and put into the studio of a Leyden artist who took pupils. In 1622 he was sent to a studio in Amsterdam. In 1623 he seems to have been working as an artist and there is a signed and dated picture of 'Saint Paul in Prison' in the Stuttgart Gallery, which is his earliest piece with an ascertained date. By 1630 he was settled in Amsterdam, and in 1634 married Saskia van Ulenburgh, who lived with him only eight years, leaving one son, Titus. Saskia had property; and her death caused confusion in Rembrandt's affairs because of her will leaving all of this property to Titus, with only a life interest to her husband, while in the meantime Rembrandt's affairs had been in a bad condition. In 1656 he was finally sold out as a bankrupt. It is not perfectly known why the very prosperous painter who, in his early manhood, had a great deal of work to do as a portrait painter (always a profitable branch of the art), and whose etchings sold remarkably well, should have become so straitened in his circumstances. It is known that he bought very freely, surrounding himself with works of art of all kinds, of which he was a constant and diligent student, and by means of which he gave himself that knowledge of the world which he did not obtain from travel, as it appears that he never crossed the frontiers of the United Provinces. It is also asserted that a certain change in popular taste left him at one side while it followed men whom we now deem greatly his inferiors in artistic power. He had many pupils and many assistants, and even the interruptions caused by death and by loss of fortune do not seem to have checked the great production of his work, for between the time of his bankruptcy and the time of his death, 13 years later, he was as busily engaged and his work was fully as important as at any former time. The mention of a few works of art with their dates in the course of this article illustrates this fact sufficiently well.

At a very early date Rembrandt's style as a painter was fixed. It is extremely original, founded on the work of no other artist of any school, based upon a strong perception of the beauty and value of pure light and shade in nature and in art. In one sense he was a great colorist, namely in that he conceived a painting as strictly the result of a disposition and combination of the hues and tints, treating all his work with as complete a color-scheme as that used by the great Venetians. There is this peculiarity, however, that Rembrandt's coloring is sombre, and reaches its highest achievement in combinations of browns and grays with but few passages of primary color or of those hues which approximate to primary color. A blue sash may appear in a portrait, and its effect of pure, bright color may be led up to and assisted by the glimmer of steel and the warm yellowish-brown of a buff coat; but as a general thing these effects are not his happiest achievements as we see the pictures now, and those are the most delightful to us in which he departs the least from his accustomed gravity of tone. There is a certain disappearing of the subject in blackness which is very disagreeable to many lovers of painting; and it is hard to form a conception of how far this has been the result of time producing changes in the pigments. Meanwhile the effect of a brilliantly modeled head coming to light from a profoundly gloomy background and helped by the painting of costume similarly relieved by light colors upon darkness, is very pleasing to many students; and apart from his obviously surpassing ability, Rembrandt is a delightful painter to many ardent lovers of the art of painting. To painters by profession Rembrandt must always be one of the men whose work commands the highest respect.

His power of characterization is not confined to painting, and his small etchings drawn upon copper in a few straggling lines have as much of it, according to their subject, as the



From the original painting by himself.

HARMENSZ VAN RIJN REMBRANDT

largest pictures. This power of characterization lifts him almost out of the category of the painters of his period. When he has character to express, either of an individual or of a race of men, he does it with a touch and an evidence of thought entirely his own. It may sometimes take a disagreeable, even an ignominious appearance, and his drawing in a given case may not be dignified or refined or even truthful; while yet the significance of the statement he wishes to make remains uniformly distinct and positive.

Among his most important paintings are the 'Saint Paul in Prison,' in the Stuttgart Gallery, signed and dated 1627; the portrait of a man at Windsor Castle, signed and dated 1631; the portrait of his brother in the Berlin Museum, that of himself in Buckingham Palace, and that of an old woman in the Hermitage collection near Saint Petersburg; 'The Supper at Emmaus,' in the Louvre; and 'The Lesson in Anatomy,' at The Hague. There are two magnificent portrait groups, one of his middle life and one of his more advanced age; 'The Night Watch,' in the Amsterdam Museum, signed and dated 1642, and 'The Syndics of the Clothmakers' Company,' in the Amsterdam Museum, signed and dated 1661.

Of his etchings the number is so very great and the enthusiasm which they have excited among great classes of collectors and students during the 19th century is so intense, that it is very hard to name even a few characteristic specimens. The prices which they fetch at auction or at private sale are enormous (several thousands of dollars in many cases), though price is not always proportionate to merit, as rarity has much to do with this detail. Thus the famous 'Three Trees' (1643), of which a fine copy is worth as much money as a large oil painting by a modern artist, and the wonderful portrait of the 'Burgomaster Six' are not necessarily as much better than other and less costly prints as their price would indicate. Their faultless work, however, is the main consideration, and the portrait of Six must always be of extreme value when in fine condition, because the closely worked etching has caused the plate to suffer from use — there can never have been more than 40 or 50 impressions of great brilliancy. During his life and during the 18th century the so-called Hundred Guilder print, 'Christ Healing the Sick,' was the most famous; and since that time the etching, slight and but little worked over, 'The Death of the Virgin' (1639), is one of the most admired by artists of all Rembrandt's work in black and white; the wonderful portrait of the 'Goldweigher' (1639), that of the preacher, Uijtenbogaert (1635), the famous Dr. Faustus, dated 1648, and several of the landscapes, especially the 'Cottage with the Great Tree,' and the magnificent 'Omval,' dated 1645, are all etchings which are unsurpassable even among Rembrandt's own works.

The most complete book on Rembrandt, that of C. Vosmaer, 'Rembrandt, sa Vie et ses Œuvres' (1877), has furnished most writers since that time with their facts. A more recent work of great extent and thoroughness is that by Emile Michel, translated into English as 'Rembrandt, his Life, his Work, his Time' (London, 1894). This book is elaborately illustrated. Small biographies by Knackfuss (1899), Malcolm Bell (1899), Neumann (1900), some of them well imagined, are contained in the different series of Artists' Lives. The etchings form a continual study, and besides the famous work of Bartsch (1797), which is continually referred to, there have been works by Charles Blanc (1880) and Dutuit. His complete etched work has been reproduced in admirable photogravure by Armand-Durand. The English etcher and student of etchings, Sir Francis Seymour Haden, has published a small book on Rembrandt's etchings, 'The Etched Work of Rembrandt' (1879–80), in which there is a careful investigation of the authenticity of some which may be thought to be by students or imitators.

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Remedios, rā-mā'thē-ōs, or **San Juan de Los Remedios**, sän hoo-än' dė lōs rā-mā'thē-ōs, town, Santa Clara province, 32 miles east of the town of Santa Clara. It is four miles from the north coast, but is connected with its port, Caibarien, by rail, and also with the important towns of the island to the west. It is in a fertile region and carries on a good trade. Pop. about 7,000.

Remensnyder, rĕm'ĕn-snī"dėr, **Junius Benjamin**, American Lutheran clergyman: b. Staunton, Va., 24 Feb. 1843. He was graduated from Pennsylvania College, Gettysburg, in 1861 and from its theological department in 1865. He served in the Union army in 1862–3, was ordained in 1865 and has held important pastorates at Philadelphia, Savannah, and New York, and originated the movement which resulted in the adoption of a common service ritual in all American Lutheran churches. He has published: 'Heavenward' (1874); 'Doom Eternal' (1880); 'Six Days of Creation' (1886); 'Lutheran Manual' (1892); etc.

Remenyi, rĕ'măn-yē, **Edouard**, Hungarian violinist: b. Heves 1830; d. San Francisco, Cal., 15 May 1898. He studied violin at Vienna under Joseph Böhm. For his part in the insurrection against Austria in 1848 he was obliged to flee from Hungary. He came to the United States in 1849, but returned to Europe a few years later and in 1854 was appointed solo violinist to Queen Victoria. He returned to Hungary in 1860 under the amnesty, and attained great fame. Thenceforward he made repeated tours in Europe and returned to the United States in 1878, where he spent much time until his death. He possessed a high technical mastery of his instrument, but was often betrayed into exaggerations that marred the artistic effects of his playing.

Remey, rā'mĭ, **George Collier**, American naval officer: b. Burlington, Iowa, 10 Aug. 1841. He was graduated from the United States Naval Academy in 1859 and entered the navy and served with distinction on the Union side during the Civil War. When the war with Spain broke out he was placed in command of the naval base at Key West, Fla., and subsequently became commandant of the navy yard at Portsmouth, N. H. He was promoted rear-admiral in 1898, and in 1900 was given command of the Asiatic Station at Yokohama, and in this capacity directing the operations of the United States naval forces in China. He was retired in August 1903.

Remigius, rĕ-mĭj'ĭ-ŭs, **Saint,** the great apostle of the French nation: b. Laon 438; d. Rheims 13 Jan. 533. He was appointed bishop of Rheims in 459. He it was who baptized Clovis, the founder of the French monarchy, who had been converted to Christianity chiefly through the influence of his queen, Clothilde. The ceremony took place amid imposing surroundings on Christmas Day, 496. Through the example of the king and the untiring exertions of Remigius almost the whole of Gaul was Christianized in the lifetime of the latter. Consult: Migne, 'Patrologia Latina,' Vol. LXV. (which contains some of the bishop's letters); Aubert, 'Vie de Saint Remi' (1849).

Rem'ington, Frederic, American artist: b. Canton, N. Y., 4 Oct. 1861; d. 26 Dec. 1909. He studied at Yale Art School and the Art Students' League, New York, and later went west where, as cowboy and stockman on a ranch, he gathered the material that made him a success in scenes of frontier life. He contributed to the leading magazines and periodicals scenes of western military and Indian life, and also events of the Cuban War of 1897–8. Few illustrators draw the horse with so much character and life-likeness. He produced several sculptures such as 'The Broncho Buster' and 'The Wounded Bunkie.' As author and illustrator he has produced 'Pony Tracks' (1895); 'Crooked Trails' (1898); 'Frontier Sketches'; 'John Ermine of the Yellowstone' (1902); 'The Way of an Indian' (1906).

Remington, Philo, American inventor: b. Litchfield, N. Y., 31 Oct. 1816; d. Silver Springs, Fla., 5 April 1889. He entered the small-arms factory of his father at Ilion, N. Y., and for 25 years was superintendent of the mechanical department. The perfecting of the Remington breech-loading rifles and of the Remington typewriter was mainly due to him. In 1886 he withdrew into private life and in that year Wyckoff, Seamans & Benedict bought out the Remington interest in the typewriter, and an assignment having been made, took charge of the Ilion plant. In 1888 the main plant passed to Hartley & Graham, who operated it as the Remington Arms Company.

Remington Rifle. See SMALL ARMS.

Remittent Fever. See JUNGLE-FEVER; MALARIA.

Remon'strants, those members of the Reformed Church in Holland who, in the year 1609, after the death of Jacobus Arminius, continued to adhere to his doctrines, and in 1610 presented to the States of Holland a remonstrance in which they defend the grounds of their dissent from the official creeds of the Reformed Church: thereafter they were styled Remonstrants, and they are still represented in Holland by a small but scholarly and liberal sect. See ARMINIANS; RELIGIOUS SECTS.

Rem'ora, or Sucking-fish, a popular name for any species of the family *Echineidida* and order *Discocephali*. The top of the head is provided with a peculiar sucking disk, a modification of the spinous dorsal fin, composed of a series of plates arranged transversely, by means of which they attach themselves to moving objects and thus supplement their powers of locomotion. On the coast of Zanzibar and elsewhere they are used in catching other fishes and turtles, the remora being secured by a line fixed to the tail, and being sent in pursuit of the turtles, etc., to which it attaches itself by means of its sucker. The ancients believed in the remora's power of arresting and detaining ships in full sail through their suctorial powers; and Antony's galley at the battle of Actium was said to have been fixed by a remora, which defied the efforts of several hundreds of men to free the vessel.

The remoras are a group of oceanic fishes occupying a rather isolated position among the spiny-rayed *Teleostomi*. Five genera and eight species have been recorded from North American waters. Some of them appear to confine their attentions to particular species of large fishes, as the spear-fish, dolphins, etc.; others are less particular. The common species on the Atlantic coast of the United States are the shark-sucker (*Echeneis naucrates*), very frequently found adhering to large sharks as well as to other fishes; *Remora brachyptera*, the sword-fish remora; and *Remora remora*, a species widely distributed in warm seas. They are not utilized for food nor for any other purpose in this country.

Remscheid, rĕm'shīt, Prussia, Rhine province; a manufacturing centre. Its chief articles of trade are cutlery and iron wares, besides machinery, tools, silk, etc.

Rem'sen, Ira, American chemist and educator: b. New York 10 Feb. 1846. He studied at the College of the City of New York, was graduated in 1867 from the medical department of Columbia, pursued chemical courses at Munich and Göttingen, and in 1870–2 was assistant to Professor Rudolph Fittig in the chemical laboratory of the University of Tübingen. In 1872–6 he was professor of chemistry and physics in Williams College, and in 1876, upon the organization of the Johns Hopkins University, was made professor of chemistry in the new institution. He formed its chemical department and has continued to direct the numerous researches of the Johns Hopkins laboratory, the facilities of which are not excelled in the United States. Despite the large amount of executive work devolving upon him in connection with his chair, he found opportunity for considerable original investigation, including that in connection with the oxidation of aromatic substitution products, the sulphides, double halides, and the decomposition of diazo compounds by alcohol. In 1881 he made a study for the city council of a peculiar condition of Boston water, which he found due to a growth of fresh-water sponge in one of the artificial lakes from which the supply was derived. He also conducted for the National Board of Health special researches in various subjects, among them 'Organic Matter in the Air' and 'The Contamination of Air in Rooms Heated by Hot-Air Furnaces or by Cast-Iron Stoves.' He was made vice-president of the university, and frequently, in the absence of the president, Dr. Daniel Coit Gilman (q.v.), acted as president. In June 1901 he was chosen president upon the resignation of Dr. Gilman. In 1873 he was elected to the American Association, in 1875 made fellow, and in 1879 president of the chemical section, and in 1902 president of the association. He became a member of the National Academy of Sciences in 1882, and was at one time president of the American Chemical

DR. IRA REMSEN,

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Society. He founded in 1879, and has since edited, the 'American Chemical Journal.' Among his text-books are: 'The Principles of Theoretical Chemistry' (1877); 'Introduction to the Study of the Compounds of Carbon, or Organic Chemistry' (1885); 'Introduction to the Study of Chemistry' (1886); 'The Elements of Chemistry' (1887); 'A Laboratory Manual' (1889); and 'Chemical Experiments' (1895).

Remus, rē'mŭs, in the fabulous history of Rome, the twin brother of the founder of the city, Romulus, who in a quarrel slew him.

Remus, Uncle, a well-known negro character invented by Joel Chandler Harris (q.v.) and introduced to his readers in 'Uncle Remus: His Songs and Sayings' (1880). Uncle Remus, an aged plantation African, is used as the mouthpiece of quaint folk-lore tales current among the blacks of the South and detailing in picturesque and amusing fashion the adventures of Bre'r Rabbit, Bre'r Fox, and other animals. The stories, interlarded with considerable homely philosophy, were gathered with much care by the author, and awakened among students an interest in that domain of the beast-fable.

Rémusat, rā-mü-zä, **Charles François Marie**, Comte de, French politician and man of letters, son of the Comtesse de Rémusat (q.v.): b. Paris 13 March 1797; d. there 6 June 1875. He was educated at the Lycée Napoleon and entered life as a journalist and lawyer. He was a member of the Chamber of Deputies 1830–48, and in 1848–9 of the constituent and legislative assemblies, in which he voted with the friends of order. From March to October 1840 he was minister of the interior, and in 1871–3 minister of foreign affairs. He began public life as a Liberal, but ended it as a Conservative. During the Second Empire he lived in retirement, devoting himself chiefly to literary pursuits. His works include: 'L'Angleterre au XVIII. Siècle' (1856); 'Bacon' (1857); 'Lord Herbert of Cherbury' (1874); 'Histoire de la Philosophie en Angleterre depuis Bacon jusqu'à Locke' (1875); 'Abélard' (1845); 'Essais de Philosophie' (1842); etc.

Rémusat, Claire Elizabeth Jeanne Gravier de Vergennes, Comtesse de: b. Paris 5 Jan. 1780; d. 16 Dec. 1821. She was married to Comte Auguste Laurent de Rémusat, Napoleon's chamberlain, and her position made her thoroughly acquainted with the life of Napoleon's court. Her 'Essai sur l'Education des Femmes,' published 1824, received an academic *couronne*, and her 'Mémoires,' published in 1879–80, are particularly valuable for the light they throw on the court of the First Empire.

Rémusat, Jean Pierre Abel, French Orientalist: b. Paris 5 Sept. 1788; d. there 5 June 1832. He devoted himself to the study of Oriental languages, particularly Chinese, while pursuing a course in medicine, and in 1811 published 'Essai sur la Langue et la Littérature chinoises.' He received his degree as a physician in 1814 and entered one of the military hospitals, but in that year accepted the chair of Chinese which had been established for him at the Collège de France. He was admitted to the Academy of Inscriptions in 1816 and in 1818, after Visconti's death, became editor of the 'Journal des Savants.' He was one of the founders of the Société Asiatique in Paris. His works include: 'Livre des Récompenses et des Peines' (1816); 'L'invariable Milieu 'of Tsz'-tse' (1817); 'Eléments de la Grammaire chinoise' (1822); 'Mémoire sur la Vie et les Opinions de Lao-tse' (1823); 'Recherches sur les Langues tartares' (1829); etc. Consult Silvestre de Sacy, 'Notice sur la Vie et les Ouvrages de Rémusat' (1834).

Remy, Saint. See Remigius, Saint.

Renaissance, rė-nā-säṅs or rĕ-nā'sạns, a movement in learning, science, literature or art, or in all of them, in which it is thought that there is a revival of an ancient spirit and of ancient methods, or even a decided advance in intelligence without traceable imitation. The name is given especially to several movements in European history, all more or less abortive; but most of all to the great movement which began in Italy about 1300 A.D. This movement, called by the Italians the Risorgimento, consisted at first, so far as conscious effort was concerned, in the collecting of Latin manuscripts of the classical authors, and the study of them. It is noticeable, however, that this purely scholarly movement was accompanied by a general intellectual advance, of which, indeed, some evidence is to be seen in different parts of Europe, at least a half-century earlier than the time fixed above. Thus in England the monk, Roger Bacon, who died in 1294, had done a great deal of needed work in asserting the necessity of studying nature directly by observation and in a sense by experiment, disregarding in the main the opinions of churchmen, schoolmen or professors in the universities. Marco Polo, traveling with his father and uncle, at the close of the 13th century, throughout a large part of Asia, visiting China and Japan, published in his account of his voyages that which had not been guessed before about the Far East. The third Crusade, under Philip Augustus of France and Richard I. of England, had closed in 1192; and the fourth Crusade with the capture of Constantinople by the Latins ended with 1204, while the later expeditions of John of Brienne and of Louis IX. all ended by 1270: and while these expeditions failed utterly in their main object, they spread through Europe the knowledge or other races, other peoples and other scholarships than that possessed by the West. The enlightened emperor Frederick II., who died in 1250, was an enthusiastic advocate of classical studies.

So in the arts of design, the wonderful achievements of the Gothic architects, though wholly mediæval in origin, were yet a step toward modern times in the general application of sound principles of construction, studied, indeed, largely by the rule of thumb and empirically, but still affecting favorably large numbers of workmen who were kept constantly employed on important structures. All the fine arts were marked in the 13th century by a rapid and on the whole permanent gain, for sculpture in connection with the great cathedrals was developed with extraordinary rapidity and reached great excellence in truth to nature and in decorative effect: and excellent designs in color grew with the growing art of decorative glass in huge windows, while all the subsidiary arts in metal, leather, and the like were being pushed intelligently and with vigor. Moreover, in pure literature, the works of the French poets of the South and at a later time of the Centre, tended toward a larger development in poetry and prose.

Throughout the north of Europe this progress was checked in the 14th century, partly by the ruinous wars which were waged in France by English kings finding means to divide the great nobility of northwestern Europe and to retard the growth of comfort and intelligence for nearly a century. And this fact allowed the leadership to pass to Italy. Thus in 1340, when the Hundred Years' war began in the claim asserted by Edward III. of England to the French crown, Petrarch was 36 years old and in the middle of his great labors, and his friend, Boccaccio, was following him close. These are the men who are the most famous in the early pursuit of classical learning, but there were associated with them men who were less known as original writers and whose names are therefore less celebrated, who yet did much of the heavy work of collecting and studying manuscript. The death of those two men in 1374 and 1375 may be thought to close the first epoch of the Risorgimento — for by this name it would be better to designate the purely Italian movement which continued for three quarters of a century.

It is to be remembered that there was still nearly a century to elapse before the general introduction of printing. The serious work done between 1340 and 1440 was done by the copying and deciphering of manuscripts, and there were no means of producing the manuscripts as cheaply and in such abundance as they were produced in the palmy days of the imperial Roman system. Then the wealthy amateur might have a number of slaves engaged in copying and mounting manuscripts, and these must have been nearly as cheap as printed books were until very recent times; but in the 14th century there was no traditional method of transcribing books other than as known to the monks of the scriptoria of monasteries, and the crabbed hand used by these transcribers must have retarded study, while at the same time no accuracy could be expected from unscholarly men under no strict and watchful supervision. These were the reasons for the marked slowness of the growth, for after the death of the two great students named above there was reaction and languor.

The fine arts were influenced at first by no study of manuscripts, but by the direct observation of Græco-Roman remains in Italy. Thus Nicolà Pisano, who died in 1278, shows in his work the effects of his own observation of Roman sarcophagi and other reliefs, and Giotto, born two years before Pisano's death, shows also, in his readiness to break away from the mediæval designs and to create for himself new dispositions of personages in sacred and legendary painting, a freedom which can hardly have come altogether from his own observation. These artists are not to be considered as men of the new movement; they were rather the last men of the mediæval epoch; and yet they were as truly the precursors of the Risorgimento. The work of Giovanni Pisano (about 1240–1320) and Andrea Pisano, born in 1270 but living on till 1345, marks in a still more positive fashion the beginning of a strong classical influence over the arts of design. Most influential of all was Orcagna, properly Andrea di Cione, whose active life may be set down as lasting from 1340 to 1376, and who built one of the most important buildings of the 14th century, the shrine in the church of Orsanmichele at Florence: a marvel of combined sculpture and color-inlay in an architectural composition. So, if we are considering the introduction and growth of neoclassic art at a time when all the important churches of Italy were built in that highly decorative, but insincere, misunderstood and inconsistent Italian-Gothic of the 14th century, the noble portico at Florence, called the Loggia dei Lanzi, is to be cited. It was built about 1375–80, and the designer, while he used something of the mediæval vaulting system, gave to the building an entirely non-Gothic aspect by using round arches of great span without buttresses, depending, for the security of each abutment, upon the heavy load piled upon it. The building is designed absolutely without reference to any classical Roman structure or to the Roman system of building in any way, and it is on this account closely in harmony with the artistic work done during the same epoch in painting and in sculpture. All the arts of design were at this time newly inspired by the great perfection of classical remains, and under this new inspiration turned away from the mediæval system, which, indeed, had never obtained a strong hold upon the Italians. Thus in the matter of fine art is the true Risorgimento a splendid epoch of early enthusiasm, which is seen prolonged into the next century and reaching its most glorious culmination in the cupola of the Cathedral of Florence, which was the work of Filippo Brunelleschi, born in 1377, and himself a sculptor of renown. He had studied in Rome and, according to the tradition, was especially interested in the cupola of the Pantheon, and yet when the managers of the cathedral employed him to roof the open central octagon of their great church, he built nothing in the least degree resembling any classical dome, but chose an outline nearly like that of a pointed arch, an octagonal plan, and a soaring cupola which dominates the whole structure, and is admirably adapted to its general Gothic style of design. This same Brunelleschi was desirous, however, to introduce the classical orders, and his important work, the chapel of the Pazzi connected with the church of Santa Croce in Florence, is the first neoclassic building.

Of nearly the same epoch as this of the architectural Rebirth is to be put down the complete triumph in sculpture of that semi-classical school which indeed used the science and the skilled conventional modeling of the Græco-Roman masters, but never their manner of thought or their artistical conception. Lorenzo Ghiberti (1380–1455) and Donatello (1386–1466) are the strongest men of this period, but Lucca della Robbia, who died about 1482, was in the first place an exquisite and many-sided artist in marble and bronze and was also the introducer of that great system of colored and glazed terra-cotta which is known by his name and which is the most unique and brilliant art of the time. Other sculptors there were, less famous but hardly less exquisite, and of them the chief is perhaps Mino da Fiesole (1400–1486). The painters of this time are too numerous to be treated here (see PAINTING); and the special biographies of the artists of the time, especially Fra Angelico (1387–1455), Masaccio (1401–28), Fra Filippo Lippi (1412–68), Mantegna (1431–1506), Sandro Botticelli (1447–1515), Leonardo da Vinci (1452–1519), Raphael (1483–1520).

The beginning of the Renaissance in the North is with the invasion of Italy by Charles VIII. of France, successor of Louis XI. This expedition began in 1494, and within a few years from that time the French nobles who had accompanied him on his march began to return, with their minds full of new ideas as to what was possible in painting and in sculpture of the human form, and also what was to be done in the way of scholarship. Not only nobles, but men of letters, students of the universities, writers, even churchmen to a certain extent, became converted to the idea of a larger and more varied art and one which in their opinion could be based upon classical examples — and this in poetry as well as in architecture, in prose writing as well as in painting.

The discovery of America and the beginning of the great voyages undertaken by the Spanish, Portuguese and French made this second step in the Renaissance (for by this name we should call it from this time on) a thing more general than even the study of literature and art could have made it alone. By this time, too, printing had become common. By 1494 many books had been printed, the Latin letter introduced by the Italian scribes had driven out "Black Letter" for all important printing in the South of Europe, and books, though not yet cheap, were accessible, and were of superior trustworthiness in this — that all the copies of an edition were assuredly alike.

The Renaissance in the North seems to moderns in the main an artistical movement, because, at the close of the 15th century, when peace succeeded devastating war in western Europe, the spread of learning had become so general that it no longer presented the limited nature of a deliberate, studied revival. Thus François Villon (1430–about 1490) presents in his verse and his order of thought a completely modern or non-mediæval aspect, and one who may be called his successor, François Rabelais (1495–about 1553) may be thought to accept the new learning as a thing entirely recognized and within everyone's reach, much as scholars of the 19th century receive whatever their predecessors have left for them without considering the immediate causes of that achievement. But the change in architecture and all the arts of decoration was most visible beginning with the work of Jean Bullant, who flourished about 1540, Jacques Androuet du Cerceau, of about the same epoch, and Philibert Delorme, a very few years later. The question of sculpture in France at this time is a very curious and a somewhat difficult one. There had been, between 1450 and the accession of Francis I., in 1515, a brilliant development of an almost wholly national art in the hands of such able men as Michel Colombe, Jean Perréal, Ligier Richier and others, who indeed show a Flemish influence on the one hand and an ultramontane, or at least a semi-classical influence on the other, but who are certainly French or Burgundian in their main tendencies. These men were busily engaged in creating a school of sculpture, the natural result of the great Gothic school pushed to greater realism and inspired with profounder knowledge. This school was destroyed by the purely classical influence coming from Italy, and at the same time the buildings of the Chateau of Ecouen (the façade on the court, more especially), those of the new Louvre, of the Palace of Fontainebleau, mark the definite adoption of Roman architecture as the standard toward which all efforts should tend. This classical tendency grew always stronger through the reigns of Francis I. (1515–47) and Henry II. (1547–59), until all art seems to perish together during the miserable religious wars of the years from 1560 to 1600.

The strange result of the Renaissance in the North was that neither painting nor sculpture reached any great achievement from the time that the classical influence was fully established until the middle of the 17th century. There were exceptions, especially in Germany, where the classical influence was less strongly felt — where it came slowly and took but a feeble hold. There the great and thoughtful artist, Albert Dürer, who died in 1528, was succeeded by the more learned and more skilful though not more artistic painter, Hans Holbein the Younger (1497–1543). In like manner there was in France and Germany as well as in the Low Countries a splendid non-classical architecture, which is worthy of study on account of its unique character. The disposition was to build with nearly the old Gothic forms, with the same high roofs, the same free placing of windows, the same disposition of the masses, while the pointed arch and other Gothic details were wholly abandoned, and even certain parts studied rather carefully from Italian examples were introduced. Thus the chateaux on the Loire and other parts of northern France, the famous town houses of what is now Belgium, and the later churches and municipal buildings of Germany and what is now Austria, were built on these lines. The buildings are by no means classical, either in proportion or in detail, neither are they Italian; and yet they are altogether different from what was built as long as the Gothic school held sway.

It has been customary among French writers to date the beginning of the Renaissance in architecture in the very heart of the flamboyant Gothic period; thus a church like that of Saint Riquier, in northern France, Saint Maclou at Rouen in Normandy, and the famous church of Brou at Bourg-en-Bresse in the south of France, are called buildings of the early Renaissance, while at the same time they are unquestionably Gothic in their conception. In this way the not perfectly definite architecture of the northern Renaissance passes on through many interesting developments until in the 17th century it is replaced by the formal work of the reign of Louis XIV. and his contemporaries.

In dealing with England and Scotland it is not usual to speak of the Renaissance at all. There were, of course, students there of the new learning, but the wars of the Roses interfered to check the growth of this, and the interest in the theological struggles of the day seems to have put an end to it altogether. The architecture known as the Elizabethan and that which followed it, known as the Jacobean, stand for the Renaissance architecture of England, and this, like the building of the Continent, shows a mixture of the Gothic with the semi-classical element.

An interesting question is that which concerns the close of the Renaissance. It has always been customary for the Italians to see the termination of the Risorgimento in the complete victory of the principles which it represents. Obviously it is no longer a "re-arising" when the end is gained; and therefore the Italians speak of the period as ending with its highest achievement. Michelangelo, who died very old (1564), is the great artist of the very close of the Renaissance. Jacopo Sansovino (died 1570) may be considered even as outside of it and coming later. Titian, Tintoretto, Veronese, and all the great Venetians are hardly ever classed as men of the rebirth. After 1550 the *decadenza* begins: or, at least, the *classicismo* is then well established, and from this the decadence soon follows. So in France it is usual to speak of the Renaissance as closing with the religious wars under the three sons of Henry II., and the art of the time of Henry IV., as of his successors, is outside of it. It is, on the other hand, customary among English writers dealing with the subject of architecture, to speak of all the neoclassic buildings since the 15th century as "Renaissance architecture." In this way even well informed architects and esteemed writers on the subject assume that Saint Peter's Church in Rome, and even Saint Paul's in London, are as much buildings of the Renaissance as the Chateau of Blois or that of Chambord. It would be altogether better for the accuracy of our thinking if this loose way of ascription could be avoided.

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Renaissance Painting. In central and northern Italy, in the 14th century, the *Giotteschi*, or scholars and imitators of Giotto, soon lost the inspiration and initiative of his art. His great principle of the direct study of nature was much neglected; portraiture, which he had undertaken with imperfect knowledge, became a distinct branch of the art only in the 15th century; and the landscape sentiment was as yet undeveloped. Nevertheless, the seeds of the great awakening of the human intellect, which brought with it a knowledge of antique art and a new intimacy with both Nature and contemporary man,— and a consequent development of all the arts,— were germinating; it appeared almost in the first decade of the 15th century in both Italy and the Netherlands. For this Renaissance, the art of painting presented the most favorable means of expression, of rendering the spiritual rather than the merely corporal, the intangible as well as the appearance of reality; and also as an outlet for the individuality which had been so long smothered under formulas and conventions. Rather curiously, this restoration of a long-lost art began, among the Flemish painters, with a suddenness, a completeness, which it was impossible to maintain,— the first great work which figures in the history of this restoration, the great altar-piece in the church of St. Bavon in Ghent, painted by the brothers Huybrecht (Hubert) and Jan van Eyck (q.v.), is an example of completeness of pictorial representation, spiritual and technical, which the survivor of these painters himself was not able to equal in his other works. The mastery seems complete even of the new process of oil painting, which they are generally credited with having first practically employed. (See OIL PAINTING.) Contemporary with this Flemish school of Bruges and Ghent was another of Brabant, with the centre in Brussels, founded by Rogier van der Weyden (q.v.), similar in tendencies. Holland developed an independent school, at Haarlem, the chief of which was Dierick Bouts (d. 1475), whose works show the influence of Van der Weyden, but are marked by somewhat greater luminousness and richness of color and display a knowledge of aerial perspective in landscape. In the paintings of Hans Memlinc (q.v.) of Bruges many of the archaic qualities of his predecessors disappear and are replaced by a greater suavity and feeling for beauty. The influence of the Van Eycks extended down to the end of the 15th century, and Flanders was the seat of a great artistic production, painters and students passing backward and forward between her borders and those of Italy. In France, in the latter part of the century, there was a northern school, and a smaller one in Provence, at the court of René d'Anjou; but the important paintings of this period were nearly all destroyed in the religious wars and the Revolution, and our knowledge of the art is derived chiefly from the miniatures.

The patronage which had been extended to the new art in the Netherlands, by princes, corporations, the Church and private individuals, in the 15th century, was continued in the early years of the 16th. Foremost among the important representatives of the Northern spirit was Quinten Massys (q.v.), or Massijs, of Antwerp (d. in 1530). Jan Gossart (q.v.), called Mabuse, from his native town of Maubeuge in Hainault, on the contrary, after his journey to Italy, adopted many of the characteristics of the Southern painters, which found favor in the eyes of his countrymen. The Dutch painters of this period were numerous; the first to become widely known abroad was Lucas Jakobsz (q.v.), called Lucas van Leyden. The movement toward realism and naturalism was slower in the schools of Germany, the chief of which was that of Cologne; the earliest important work now extant is the large altar-piece, a triptych, known as the *Dombild*, painted by Stephen Lochener (d. 1451). The painters of this school substituted for the pictorial or distant backgrounds of the Flemings generally a flat, gold one, and they differed from them also in their retention of the disk-shaped nimbus behind the heads. The Swabian school, chiefly Alsatian, was distinguished by a remarkable artist, a bold innovator, Martin Schongauer (q.v.), the greatest master in Germany of his time, but now best known by his drawings and engravings. The schools of Ulm, Nördlingen and Augsburg were more or less influenced by the Flemish art; two families of painters, the Burckmairs and the Holbeins, combined to raise the fame of Augsburg to the highest degree. In both, an illustrious father was succeeded by a still more illustrious son,— Thoman Burckmair by Hans (q.v.), and Hans Holbein, the elder (q.v.), by his famous son of the same name. The latter, and his brother Ambrosius, are found in Basel in 1515–16. As the most brilliant representative of the German Renaissance, Hans Holbein, the younger (q.v.), rose superior to the limitations of the art of his time, and excelled in all branches. His large mural paintings have all been destroyed; but the votive picture executed for the family of the Burgomaster Meyer in 1526, his portraits — including those of the period of his sojourn in England at the court of Henry VIII.— and his designs and engravings, have been preserved. From the Franconian school, of which Nuremberg was the centre, came the most formidable of his rivals, Albrecht Dürer (q.v.), a pupil of Michael Wolgemut, painter of altar-pieces and of careful portraits, and a skilful wood-engraver. The influence of Nuremberg was diffused over a wide area,— Schleswig, eastern Germany, Bohemia and Poland.

In the north of Europe, the spirit of the Renaissance lagged somewhat behind as compared with its development under the sky of Italy. Climatic conditions, the influence of the Gothic in making angular the forms and the draperies and in diminishing the wall spaces for mural painting, a neglect of the close study of the human body, of proportion, of perspective, a general empiricism in the sciences, the scarcity of examples of antique art, a lack of intelligent and munificent patronage in Germany, even the Reformation itself,— all have been given as partial explanations of this inferiority. Notwithstanding his genius, his earnest researches, and his journey to Italy, Dürer's art remained hampered throughout his life by his mediæval limitations. The Italians, who fully appreciated his work, his imagination and intellectual power, declared that he would have been as great as the greatest of their own artists if they had been born in Florence or Rome and had studied the antique. His great influence over his contemporaries was extended by his engravings. Dürer's chief rival among his contemporaries was Albrecht Altdorfer, the Ratisbon master. Lucas Cranach, the elder, so called from his natal town in Franconia, established a school in Saxony, which survived for some years after his death, although unable to reproduce his strong individuality. In Upper Alsace, the renown of Martin Schongauer was continued by two painters, not natives of the province, Matthias Grünewald and Hans Baldung, the latter, also, betraying strongly the influence of Dürer. The school of Swabia, the most eminent and the most learned of the German Renaissance, boasted, in addition to the Burckmairs and the Holbeins, of Martin Schaffner, the so-called Master of Ulm, and some other painters. In the Spanish peninsula, at the period of the gradual expulsion of the Moors, the demand for church pictures brought painters from both Italy and Flanders,— from the latter, among others, Jan van Eyck and Rogier van der Weyden.

Among the causes that contributed to the development of the full flower of the Renaissance in Italy,— in addition to those already mentioned,— may be cited the humanistic spirit, derived largely from the enthusiasm arising from the study of the antique, a general aspiration toward the noble and the beautiful, a new ideal of humanity. Contemporary with this was a revival of learning,— more complete than in Germany. The art of painting, however, it was necessary to re-invent; the study of the human figure, the all important subject in the art of the Renaissance, was undertaken scientifically. Church painting remained for a long time the principal feature, and it was greatly favored by the abandonment of the old Gothic type and the division of the field into panels — which permitted of larger wall spaces, of pictures even longer than they were high. These were executed in fresco, the method perfected in the school of Giotto,— *buon fresco,* painting on the last or smooth coating of plaster freshly applied to the wall and while still wet. That which could not be painted upon in the course of the day was cut out and replaced with fresh lime the next morning. In this manner the color becomes an integral part of the wall. The pigments were water colors, usually earths and minerals. Subsequent retouching was necessarily done *al secco,* on the dry wall, and this was generally considered regrettable and somewhat dangerous to the conservation of the painting. Sometimes in the contracts for decorative works we find this retouching insisted upon. Encaustic painting seems to have also been known; tempera and oil painting were usually observed for altar-screens and easel pictures, these being generally panels covered with a thin layer of plaster. For their studies and drawings, the artist worked in monochrome or *gris aille,* called by the Italians painting in *chiaro oscuro*; their colors were ground by their apprentices under their own eyes and selected with great care. The art of painting, the most eloquent expression of the Renaissance, was destined to outstrip the other manifestations, science and letters, if not architecture. Florence remained the chief seat of this art in the 15th century as in the time of Giotto, though her authority was much less than in sculpture; the leaders were Masolino and his pupil Masaccio (q.v.), to the latter is attributed the honor of having invented a new style in painting. Very different from his intelligent naturalism and fine sense of distinction was the sincere and naive piety of the work of the Dominican friar Fra Giovanni da Fiesole (q.v.), called Fra Angelico; and still more so the tasteless "realism" of Paolo di Dono, known as Paolo Uccello (q.v.). Foremost amongst the direct heirs of Masaccio were Fra Filippo Lippi (q.v.), and his son, called Filippino Lippi (q.v.); the paintings of the former betraying new qualities of color and of *morbidezza.* With him originated a new type of the Madonna, afterward given its highest expression by Leonardo and Raphael, — a presentation in which only the human idyl of motherly love and infantile innocence is sought. In the religious as in the allegorical and mythological subjects of Sandro Botticelli (q.v.), something of the mediæval awkwardness of expression reappears, redeemed by the grace and charm of the conception and the color. With him are associated as exponents of a modern, ingenious spirit, Benozzo Gozzoli (q.v.), a pupil of Fra Angelico, and Pinturicchio (q.v.). Andrea Verrocchio (q.v.) is most popularly known as a sculptor, principally by his equestrian statue of Colleone, the Venetian general; Domenico Ghirlandaio (q.v.), less original than Masaccio but more finished in his expression of realism, was, next to him, the most important painter of the Florentine school of the 15th century, and had for a pupil Michelangelo.

Of the Umbrian school, the chief seat was Perugia, though in this province painting was not centralized in the cities; the mystical and serene spirit of Perugino differed from the vivacious and investigating character of his predecessors in the school. The first artist to feel the influence of Florence was Piero degli Franceschi (q.v.), but a more skilful was Luca Signorelli (q.v.), his pupil, whose great painting of the 'End of the World,' in the chapel of the cathedral of Orvieto (which had been commenced by Fra Angelico), furnished themes and figures to Michelangelo for his 'Last Judgment.' In the best works of the master of Raphael, Pietro Vanucci (q.v.), called Perugino, may be seen the same art, the same suavity and dignity, which characterize much of the early work of his famous pupil; he seems to have been the first in central Italy to master completely the new process of painting in oil.

In northern Italy, the most important centre of the arts was at Padua, the school there having been founded in the second half of the 15th century by Francesco Squarcione (q.v.), known as the "Father of Painters," and the discoverer of the genius of Andrea Mantegna (q.v.), whom he adopted at the age of 10. In this latter artist, one of the most learned, ingenious and original of his age, the first to master the complete rules of composition, the study of nature was happily balanced by a corresponding study of the antique. In Venice, enjoying a most unusual order and prosperity under the intelligent despotism of her dukes, the revival of art did not manifest itself strongly until the second half of this century, but its final florescence was one of the most brilliant of any age. Two families of painters appear in this first period, the Vivarini and the Bellini, the latter much the more famous. To them Antonello da Messina seems to have communicated the method of painting in oil, which they so soon mastered,— a love of color and splendor being one of the natural gifts of the Venetians. The head of the family was Jacopo Bellini (q.v.), who went to Florence early in his career; his sons were Gentile (q.v.) and Giovanni (q.v.), the latter praised by Albrecht Dürer at the period of his visit to Italy in 1506. In the works of these Venetians appears that "atmosphere" which is so diligently sought by the modern schools,— the feeling of space and air, of the relative position and value of the figures in the general arrangement; the Gothic angularity and awkwardness have been replaced by a fuller knowledge. The most eminent of the followers of Gentile Bellini was Vittore Carpaccio (q.v.) (Scarpaccia), famous for his cycle of nine pictures illustrating the legend of Saint Ursula.

The greatest name in the Renaissance proper is that of Leonardo da Vinci (q.v.), b. 1452, distinguished as a scientist, an architect, a sculptor, a musician, an author, and a painter,— and qualifying painting, himself, as the noblest of the arts and as at the same time a science But few of his pictures survive, the most famous and the most wonderful being the portrait known as the 'Mona Lisa' in the Louvre. Of his numerous followers, the most productive and the most successful in expressing some of his qualities was Bernardino Luini (q.v.). Michelangelo (q.v.), on the other hand, vehemently protested against placing painting on a level with sculpture, and, indeed, remained to the end of his days "*Michelangiolo Scultore*" rather than the painter, even in his greatest mural decorations. His first patron was Lorenzo de Medici; and it was in 1508 that the pope Julius II. commissioned him to paint the ceiling of the Sistine Chapel in the Vatican. In 1535 he commenced the 'Last Judgment' on the end wall, and it was unveiled for the Christmas festival of 1541. The qualities of his rugged genius were peculiarly those best adapted to create a school of mannerisms and conventions among his imitators, and we see his influence very strongly developed even in his lifetime, and even in the favorite pupil of Raphael, Giulio Pippi, called Giulio Romano (q.v.). To this pretentious and ignorant school of exaggerated muscular action and violent foreshortening, which flourished during the decadence of the art, was given the name of the Baroque. The art of Raphael Santi da Urbino (q.v.), so different in quality, was eminently qualified by its combination of academical distinction with suavity and grace to secure the largest need of popular favor in his own time and in succeeding ages, and his 'Madonna Sistina,' now in the Dresden Gallery, was accepted for more than three centuries as the greatest painting in the world. Andrea del Sarto (q.v.), the best colorist in the Florentine school, may be said to err only in a certain lack of deep feeling; and the versatile talent of Correggio (q.v.) leads up to the splendors of the later Venetian school of Giorgione, Palma, Vecchio and Titian, and, later still, of Paul Veronese, Tintoretto and Tiepolo, the apotheosis of the beauty of oil painting. Giorgio da Castelfranco (q.v.), so great a Giorgio that he was called Giorgione, that is, Big George, was a fellow student with Titian under Giovanni Bellini. But very few of his authenticated works survive, one of them being in the Louvre. Of Giacomo Palma, the elder (q.v.), called Palma Vecchio, more is known, over a hundred existing paintings being attributed to him, the finest being probably the altar-piece in S. Maria Formosa, Venice, a single figure of Saint Barbara. With the majestic figure of Titian, Tiziano Vecelli da Cadore (q.v.) (1477–1576), the golden period of the Renaissance may be said to end,— of all the numerous assistants who worked under him during his long life, including a brother and a son, none inherited his power. His paintings, sacred, allegorical, mythological, and portraits, are preserved in all the great galleries of Europe; the most beautiful, and perhaps the most characteristic of this school being the so-called ‘Earthly and Heavenly Love’ in the Borghese Palace in Rome. For painting after 1550, see POST-RENAISSANCE PAINTING.

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Renan, rė-nän, **Ernest,** French historian, philosopher, and essayist: b. Tréguier, Cote-du-Nord (Brittany), 27 Feb. 1823; d. Paris 2 Oct. 1892. The priests who directed the school in Tréguier conducted his education up to his 16th year. Having proved himself a scholar of distinction, Renan was chosen in 1838 by the Abbé Dupanloup for a place in the seminary of Saint Nicolas du Chardonnet in Paris. Here he remained until, in 1842, he went to Issy, near Paris, to receive a training in philosophy previous to his entering upon his studies for the priesthood. In 1844 he was admitted to the seminary of Saint Sulpice, the chief training school of the French priesthood, where he acquired a knowledge of Hebrew, Arabic, and Syriac. The result of these studies in philology was to shake his belief in Catholic orthodoxy, and finding it impossible to enter the priesthood he quitted the seminary in 1845. While he now maintained himself by teaching in a school at Paris, he continued his historical and philological studies, aided by the counsel and assistance of his sister Henriette. In 1848 he received the Volney prize for an essay on the Semitic languages, amplified and published as ‘Histoire génerale et Système comparé des Langues sémitiques’ (1855). In the following year he was sent on a mission to Italy by the Académie des Inscriptions et Belles-Lettres, and returning was appointed to a post in the manuscripts department of the Bibliothèque Nationale. His ‘L'Avenir de la Science,’ though not published till 1890, was written in 1848–9. He next published ‘Averroès et Averroisme’ (1852), and several ‘Etudes d'Histoire religieuse’ (1856). Having become known as an Oriental scholar, he was appointed a member of a commission sent by the government in 1860 to examine the remains of Phœnician civilization in Syria. It was during this journey in Palestine that he wrote his famous ‘Vie de Jésus’ (1863). He afterward dedicated it to his sister Henriette, who, having accompanied him, had died at Byblos. During his absence Renan had been appointed professor of Hebrew in the Collège de France, but some expressions of a Unitarian character in his inaugural address conspired with his well-known hostility to traditional Christianity to deprive him of his chair, in which he was not reinstated until 1871.

The publication of the ‘Life of Jesus’ in 1863 gained for its author a European reputation, and was the first of a series on the ‘Histoire des Origines du Christianisme,’ which he made the chief labor of his life. This comprehensive work included the following further volumes: ‘Les Apôtres’ (1866); ‘Saint Paul’ (1869); ‘L'Antéchrist’ (1871); ‘Les Evangiles et la Seconde Génération Chrétienne’ (1877); ‘L'Eglise Chrétienne’ (1879); ‘Marc Aurèle et la Fin du Monde Antique’ (1882); ‘Index Général’ (1883). In 1888 he was elected a member of the French Academy. During 1880 he delivered the Hibbert lectures in London on ‘The Influences of the Institutions, Thought, and Culture of Rome on Christianity,’ and also, at the same time, lectured at the Royal Institution on Marcus Aurelius. In 1883 he was appointed administrator of the Collège de France, where he continued his labors until his death. It is not yet possible to decide with any degree of certainty the ultimate effect of his work on the religious thought of Europe; but to his own generation he was a man of unique personality, and a writer of great erudition. Besides the works already enumerated the following should be mentioned: ‘De L'Origine du Language’ (1857); ‘Le Livre de Job’ (1859); ‘Essais de Morale et de Critique’ (1859); ‘Le Cantique de Cantiques’ (1860); ‘Mission de Phénicie’ (1865–74); ‘Questions contemporaines’ (1868); ‘La Réforme Intellectuelle et Morale’ (1872); ‘Dialogues philosophiques’ (1876); ‘Mélanges d'Histoire et de Voyages’ (1878); ‘Corpus Inscriptionum Semiticarum’ (1881–9); ‘L'Ecclésiaste’ (1882); ‘Souvenirs d'Enfance et de Jeunesse’ (1883); ‘Nouvelles Etudes d'Histoire réligieuse’ (1884); ‘Discours et Conférences’ (1887); ‘Histoire du Peuple d'Israël’ (1887–94); ‘Feuilles détachées’ (1892); and several dramas, such as ‘Caliban’ (1878), ‘L'Eau de Jouvence’ (1880), ‘Le Prêtre de Nemi’ (1885), and ‘L'Abbesse de Jouarre’ (1886). His ‘Lettres intimes’ (1896) are a fitting memorial of his devoted attachment to his excellent sister Henriette.

Around Renan's writings were waged bitter controversies «whose volume is rivalled only by their acrimony.» Into those discussions it is not now necessary to enter. Renan was a kind of Democritus, viewing the world as «a charming promenade,» or a pleasing spectacle with Renan in an orchestra-stall; speaking of it all with an amiable irony. Truth was to him a diamond of many facets, and he was never ready to define his position. One thing, indeed, he was confident of — his own genius. Yet he was compact of strange contradictions; for he said that he alone in his time comprehended Saint Francis of Assisi, urged doubtful priests to remain in the church, and having, as most thought, struck as severely as he could at faith, deplored its passing in France. The ‘Vie de Jésus’ was received by even French readers with a large reserve on the score of taste. Based on the critical work of radical German theologians, it endeavored to reconstruct the life of Christ by the so-called scientific method of history and psychology, and to treat a subject which previous critics had approached with respect for its special character in a manner which at times amounted almost to caricature. Renan's style has been highly praised for simplicity and restraint. His influence remains strongly in French literature. The best biography of Renan is that of Madame Darmesteter (1898). Consult also: Sainte-Beuve, 'Nouveaux Lundis' (1863–72); Grant Duff, 'In Memoriam' (1893); Monod, 'Maitres d'Histoire' (1895).

René, rė-nā, or **Renatus I.** (rĕ-nā'tŭs) **of Anjou** (called also The Good), titular king of Naples: b. Angers 16 Jan. 1409; d. Aix 10 July 1480. He was the second son of Louis II., Duke of Anjou. He inherited Anjou and Provence, besides claims upon Naples, Sicily, and Jerusalem from his brother Louis III. in 1434, and these rights were confirmed by Joanna II. before her death in 1435. René had in 1420 married the daughter of Charles II., Duke of Lorraine, and had in 1431 become possessed of that dukedom. But in the same year Count Antony of Vaudemont took him prisoner, whereupon the Lorraine states appealed to the Emperor Sigismund to decide the quarrel. René in 1432 was released from his prison for a year by giving his sons as hostages. At last, in 1434, Sigismund gave a decision in René's favor. The dethroned Antony proceeded to the Duke of Burgundy, who required René again to place himself in custody. Scarcely had this been done when an embassy arrived to tender him possession of Naples and Sicily. Philip refused to set René at liberty, and the ambassadors therefore conferred the crown on his wife Isabella, whom her husband named regent of Anjou, Provence, Naples, and Sicily. Isabella set sail for Naples, but there found a competitor in Alfonso, king of Aragon, who maintained his position not only against her, but also against René himself, after he had obtained his liberty in 1437. René, obliged to abdicate, returned to Provence. The government of Lorraine he gave up to his son John, who, after his mother Isabella's death, entered into full possession under the title of John II. On this René retired to Provence to give himself to poetry and the arts. His literary remains were edited by Count de Quatrebarbes (1875).

René II., count of Anjou, grandson of René I.: d. 1508. He inherited Vaudemont, Joinville, Aumale, Mayenne, and Elbœuf in 1470 from his father, Frederick II.; and Lorraine from his mother in 1473. In 1480 he acquired the dukedom of Bar. He fought with the Swiss against Charles the Bold of Burgundy in 1477. After his grandfather ceded Lorraine to Louis XI. he tried to establish his rights by force of arms.

Renée of France, Duchess de Ferrara, French princess, daughter of Louis XII.: b. Blois, France, 1510; d. Montargis, France, 1575. She was highly educated, possessed a keen intellect, and took a deep interest in religious controversies. In 1527 she was married to the Duke de Ferrara and in 1535 was converted to Protestantism by Calvin. Her conduct was displeasing to her father who caused her four children to be taken from her and educated in the Catholic faith, and also ordered severe restrictions concerning the princess' freedom of action and compelled her to attend mass. After the death of the duke in 1559 she returned to France and resided in her castle of Montargis, where she was the patron of the French Huguenots and also of various literary celebrities. Consult: Catteau-Calleville, 'Vie de Renée de France' (1781); 'Memorials of Renée of France, Duchess of Ferrara' (1859); Fontana, 'Renata di Francia, duchessa di Ferrara' (1888–93); Rodocanachi, 'Renée de France' (1896).

Ren'egade, one who renounces his religious belief and adopts another; in particular one who gives up Christian belief for Mohammedanism: a renegade is also a traitor who, deserting the cause of his country, enters the service of his country's enemies. Among famous renegades in this sense are: Hippias, the Athenian, son of Pisistratus, who fought on the side of Sparta against Athens, and afterward joined the Persians; the Roman patrician Coriolanus, who, when exiled from Rome, took up arms with the Volscians against his country; in the Thirty Years' war, Count Mansfeld, who deserted from the Catholic to the Protestant side, and Pappenheim, who deserted from the Protestant side to the Catholic; in the 18th century the Duke de Riperda, who had won distinction in the military service of Spain, embraced Islam and led the armies of Morocco against Spain.

Reni, Guido, gē'dō rā'nē, Italian painter: b. Bologna 4 Nov. 1575; d. there 18 Aug. 1642. His first instruction was received in Calvaert's celebrated school at Bologna where he studied the works of Albrecht Dürer. When the school of the Caracci, at Bologna, began to eclipse that of Calvaert, Guido, then 20, joined it. He visited Rome for the first time in 1602, with two of his fellow students, Domenichino and Albano. He made a second visit in 1605 and Cardinal Borghese employed him to paint a 'Crucifixion of Saint Peter' (now in the Vatican) for the church Delle Tre Fontane. The powerful manner of this picture, and several others of the same period, which manner Guido did not, however, long retain, increased his fame; and at the cardinal's request, he completed the 'Aurora' on the ceiling of the Casino in the Rospigliosi Palace. This picture has become well known and popular from the engravings of it by R. Morghen, J. Burger, and others. Paul V. at that time employed Guido to decorate a chapel on Monte Cavallo, with scenes from the life of the Virgin Mary. Guido accomplished this work to the satisfaction of the pope, and was next entrusted with the painting of the memorial chapel in Santa Maria Maggiore. To this period his 'Fortuna,' and the portraits of Sixtus V. and Cardinal Spada may be assigned. His paintings are very unequal in style and character, but generally are considered as belonging to three different manners and periods. The first comprises those pictures which resemble the manner of the Caracci, and particularly that of Caravaggio. Faces and forms, stately and grandiose, deep shadows, narrow and intense lights, high coloring, in short, an effort after great effect, distinguish his works of this first period. The second manner is completely opposed to the first and shows the painter at his best, being sweet, natural, and unstrained. Its principal features are tender coloring, little shade, an agreeable, though often too dainty, airy and sentimental, treatment of the subject, constituting a style quite peculiar to Guido. His 'Aurora' forms the transition from the first to the second style of his paintings. A third period commences at the time when Guido worked with too much haste and had become more avaricious of money than of fame. His coloring has turned to a greenish and altogether unnatural grayness, and the general treatment is careless and weak. During the government of Pope Urban VII. Guido quarreled with his treasurer, Cardinal Spinola, respecting the price of a picture, and returned to Bologna. There he had already executed his 'St. Peter and Paul' for the house Zampiere, and the 'Murder of the Innocents' for the Dominican church, and was on the point of embellishing the chapel of the saints with his pictures when he was called back to Rome, loaded with honors, and received by the pope himself most graciously. But he soon experienced new difficulties, and in 1622 accepted an invitation to go to Naples. Believing himself unsafe at this place, on account of the hatred of the Neapolitan artists for foreign painters, he returned once more to his native city, never to quit it again. At Bologna he painted two beautiful pictures for the church Dei Mendicanti, an 'Assumption' for Genoa, and a number of others for his native city and other places, particularly for Rome. There is also a 'Magdalen' by this artist in Chiswick House, belonging to the Duke of Devonshire, of which there is an engraving by Sir Robert Strange. Equally celebrated is a painting of 'Lot and his Daughters,' in the Hampton Court collection, also engraved. In the gallery of the Louvre are several, of which the finest is the 'Centaur Nessus carrying off Dejanira.' In the Dresden Gallery is his 'Christ Wearing the Crown of Thorns.' Consult Bolognini-Amorini, 'Vita del celebre pittore Guido Reni' (1839).

Rennell, rĕn'ĕl, **James**, English geographer: b. Chudleigh, Devonshire, 3 Dec. 1742; d. London 29 March 1830. At 13 he entered the navy as midshipman, and was present at the siege of Pondicherry. In 1763 he entered the East India Company's sea service; the next year was appointed surveyor-general of the East India Company's dominions in Bengal and remained in the service for 13 years. Returning to England in 1777 he published his 'Bengal Atlas' (1779), a work of the highest importance for administrative and strategical purposes. This was followed by the earliest approximately correct map of India with a memoir (1783). The Royal Society, of which he had been a fellow for 10 years, gave him the Copley medal in 1791. His attention was thereafter directed to comparative geography, and in pursuance of his scheme for a great work on western Asia he published 'Geographical System of Herodotus Explained' (1800); 'Observations on the Topography of the Plain of Troy' (1814); and 'Illustrations of the Retreat of the Ten Thousand' (1816). Finally came 'A Treatise on the Comparative Geography of Western Asia' (1831). He contributed much to the field of African geography, constructing a map of northern Africa for the African Association, and determining the routes taken by Hanno and in his own day by Mungo Park. Throughout his life he had been interested when not personally occupied in marine surveying and collected an immense mass of data which he began to reduce to a system about 1810. He completed current-charts of the Atlantic which were published after his death; and the name of 'Rennell's Current' was given to the current to the southward of the Scilly Islands, whose occasional northward set he was the first to explain. He published papers on the ruins of Babylon, the identity of Jerash, the shipwreck of Saint Paul, and the landing of Cæsar. In 1801 he was made an associate of the Institute of France, and in 1825 received the gold medal of the Royal Society of Literature. He was buried in Westminster Abbey. Consult: Markham, 'Major James Rennell and the Rise of Modern English Geography' (1895).

Rennes, rĕn, France, capital of the department of Ille-et-Vilaine (formerly capital of Brittany), situated at the junction of the rivers Ille and Vilaine. It is divided by the Vilaine, traversing the city from east to west, into the High and Low Town. The High Town is elegantly built on the right bank of the river; the Low Town is unprepossessing and older (11th-13th century), and suffers from frequent inundations. The buildings of interest are: The cathedral of Pseudo-Ionic style; the archiepiscopal palace; the old parliament house; and the statues of many celebrities; the town-house, containing a fine picture gallery, Veronese, Michelangelo, Tintoretto, Van Dyck, Rembrandt, and Rubens; splendid scientific and other collections; important archives, and a large library. Rennes has courts of justice of first and second instance. The industries embrace tanneries, wax-bleaching, printing, stained paper, hats, boots and shoes, gloves, and agricultural implements. There is an extensive trade in butter, honey, wax, cotton, and linen yarns, lace, earthenware, etc. Rennes is very ancient, dating from Condate, the capital of the Gallic Redones. Pop. about 75,000.

Rennet, the prepared inner surface of the stomach of a young calf. It contains much pepsin, and has the property of coagulating the casein of milk and forming curd. It is prepared by scraping off the outer skin and superfluous fat of the stomach when fresh, keeping it in salt for some hours, and then drying it. When used a small piece of the membrane is cut off and soaked in water, which is poured into the milk intended to be curdled.

Rennie, rĕn'ĭ, **George**, English civil engineer, son of John Rennie (q.v.): b. London 3 Dec. 1791; d. there 30 March 1866. He was educated at the University of Edinburgh and in 1811 entered the office of his father. He was inspector of machinery of the mint in 1818-26 and in 1821 engaged with his brother Sir John Rennie (q.v.) in completing several important works begun by their father, among which were the breakwater at Plymouth, various docks, harbors, canals, and the London Bridge. He laid out the Liverpool and Manchester railway in 1826, was chief engineer of the Namur and Liège railway in 1846, constructed the first screw-propelled ship in the British navy, the Mermaid, in 1840, and was engaged in the construction of naval works at Sebastopol, and other foreign ports besides those in English harbors. After the retirement of his brother, Sir John, in 1845, he conducted the business of the firm in partnership with his two sons. He was made a fellow of the Royal Society in 1822, was its vice-president in 1845, and treasurer in 1845–50.

Rennie, John, Scottish civil engineer: b. Phantassie, Haddingtonshire, 7 June 1761; d. London 4 Oct. 1821. At an early age he showed an interest in mechanics and frequented the shop of the millwright Andrew Mickle, inventor of the threshing machine. Later he spent three years at Edinburgh University, and in 1784, having already established a business of his own, he visited James Watt at Soho, Staffordshire, and by Boulton and Watt was engaged to take charge of the work of the Albion Flour Mills, Blackfriars, London. Rennie designed all the machinery, using iron instead of wood for the shafting and framing. In London his reputation rapidly increased, until he was ranked foremost among the civil engineers of Great Britain. Among his public works may be mentioned Ramsgate Harbor; Waterloo and Southwark Bridges, across the Thames, and the design of London Bridge, the structure being completed after his death; the breakwater at Plymouth, and several similar structures, where submarine masonry was carried to great perfection. He superintended likewise the execution of the Grand Western Canal, from the mouth of the Exe to Taunton; the Polbrook Canal, Cornwall; the Aberdeen Canal, uniting the Don and the Dee; that between Arundel and Portsmouth; and, his chief work in connection with inland navigation, the Kennet and Avon Canal, between Bath and Newbury, the London Docks, the East and West India Docks, the Prince's Dock at Liverpool, and those of Dublin, Greenock, and Leith were also designed by him. In prosecuting his works he made use of the diving-bell which he greatly improved, and the steam-dredging machine, apparently without the knowledge that in its invention he had been anticipated by Sir Samuel Bentham.

Rennie, Sir **John,** English civil engineer, younger son of John Rennie (q.v.): b. London 30 Aug. 1794; d. Bengeo, near Hertford, Hertfordshire, 3 Sept. 1874. At 16, he like his brother, began the study of engineering under his father. When his father died in 1821 he continued with his brother George to carry on the extensive business left in their hands. He made hydraulic engineering a special study, and through his efforts large tracts of land on the eastern coast of England, including part of the Lincolnshire fens, were reclaimed and made extremely productive. The finest works of the Rennies are their bridges, which may be seen in all parts of England and Scotland, London Bridge being the most massive of them all. On the occasion of the opening of this bridge in 1831 John Rennie was knighted, an honor his brother declined. After the dissolution of the partnership in 1845 Sir John practised as an architect. He introduced the system of railways in Sweden, made important surveys of the harbor of Oporto in Portugal, and designed, and in great part executed, the harbor of Ponte Delgada in the Azores, one of his latest public works. In 1845 he was elected president of the Institute of Civil Engineers. He was the author of 'Theory, Formation and Construction of British and Foreign Harbors' (1851–4). Consult his 'Autobiography' (1875).

Ren'no Renappi, the native name for the Delaware Indians (q.v.).

Reno, rē'nō, **Conrad,** American lawyer: b. Alabama 28 Dec. 1859. He was graduated from the Boston University Law School in 1883 and has since practised his profession in Boston. He has published: 'State Regulation of Wages' (1891); 'Non-Residents and Foreign Corporations' (1892); 'Employers' Liability Acts' (1896–1903); 'History of the Judicial System of New England' (1900).

Reno, Jesse Lee, American military officer: b. Wheeling, W. Va., 20 June 1823; d. South Mountain, Md., 14 Sept. 1862. He was graduated from West Point in 1846, served with distinction in the Mexican War, was assistant professor of mathematics at West Point in 1849 and at the outbreak of the Civil War was commissioned brigadier-general of volunteers. He performed gallant service at Roanoke Island, Newbern, and Camden, and was promoted major-general in 1862. He participated in the battles at Manassas and Chantilly, and after repulsing the Confederates under General Lee at South Mountain, three days before the battle of Antietam, he was killed while leading a charge.

Reno, Jesse Wilford, American inventor, son of J. L. Reno (q.v.): b. Fort Leavenworth, Kan., 4 Aug. 1861. He was graduated from Lehigh University in 1883, afterward pursuing a special course in mining and engineering. In 1885–90 he was engaged in mining in Colorado, and later became an electric railway expert. In 1892 he invented the inclined elevator or moving stairway (see Escalator) and in 1895 became president of the Reno Inclined Elevator Company.

Reno, Marcus Albert, American military officer: b. Illinois, about 1835; d. Washington, D. C., 31 March 1889. He was graduated from West Point in 1857, and at the outbreak of the Civil War was made 1st lieutenant in the United States army. He was promoted captain in the same year, brevetted major for gallantry at Kelly's Ford, Va., in 1863, lieutenant-colonel for services at Cedar Creek, and in 1865 was brevetted brigadier-general of volunteers and colonel of regulars for distinguished service throughout the war. In 1876 he was engaged in the campaign against the Indians under Sitting Bull, holding command second to General Custer. In the engagement in which Custer and nearly all his regiment were killed, Reno escaped through cowardice and in consequence of his failure to support his associates and other serious charges he was dismissed from the service.

Reno, Nevada, city, county-seat of Washoe County; on the Truckee River, and on the California & O., the Southern Pacific, and the Virginia & T. R.R.'s; in the extreme western part of the State, about 30 miles south of Carson City. It was settled in 1858 by eastern emigrants who had started for California. It was incorporated in 1869, and in 1901 was chartered as a city. It is in a farming and stock-raising region, and is the most important and largest city in the State. The chief industrial establishments are railroad machine shops, which have 2,200 employees; abattoir and packing house, 120 employees; electric-power plant, 50; pressed brick works, 25, and a number of smaller manufactories. The trade is chiefly in farm products, live-stock, and manufactures. It is an important distributing point for a vast territory. The principal public buildings are a government building, eight churches, and the Nevada State Hospital for Mental Diseases. The educational institutions are the State University, opened in 1886, State Agricultural College and Experiment Station, a normal school, Academy of Our Lady, public and parish schools, and a Carnegie Library. The three banks have a combined capital of $1,500,000, and the annual amount of business is $38,000,000. The government is vested in a mayor and a city council of five members, all of whom are elected by the people. Pop. (1890) 3,563; (1900) 4,500; (1910) 10,867.

C. A. NARCROSS,
Editor 'Reno Evening Gazette.'

Renoir, rė-nwär, **Auguste,** French painter: b. Limoges 1841. He exhibited at the first Impressionist Salon in 1874 after studying under the impressionist Monet and others of the same school. While he paints figures, principally, and possesses singular skill in depicting flesh color and skin texture, as well as facial expression, he has remarkable success in landscape, in fruit and in flowers, which he sets on the canvas with astonishing boldness, and vividness of presentation, and he is certainly one of the most original and independent of the school to which he belongs. His 'Jeunes Filles au Piano' is a good example of his qualities. Among his portraits are those of Claude Monet, his master, and the composer Wagner. Consult: Duret, 'Les Peintres Impressionistes' (1879).

Renouf, rė-noof, **Emile,** French painter: b. Paris 1845; d. there 1894. He chose for his subjects the scenery of the sea and incidents in the lives of those who live on the seashore, fishermen, etc., but he also did some good work in landscape and genre. His fine marine 'After the Storm' is in the New York Metropolitan Museum, and his 'Helping Hand' (a child holding to an oar, while a sturdy fisherman rows), is in the Corcoran Gallery, Washington. While in New York (1887–8) he painted 'Brooklyn Bridge,' which at present is in the public gallery at Havre. In 1883 he was awarded a first class medal at Munich.

Renouf, SIR **Peter Le Page,** English Egyptologist: b. Guernsey 23 Aug. 1822; d. London 14 Oct. 1897. He was educated at Elizabeth College, whence he passed to Pembroke College, Oxford, where he came under the influence of Newman and the Tractarians, and in 1842 entered the Roman Catholic Church. From 1855 to 1864 he was professor in the Catholic University of Ireland, first of French literature and the history of philosophy, and subsequently of ancient history and Oriental languages. He began his career as an Egyptologist about 1860, and in 1863 defended the work of Young and Champollion against Sir George C. Lewis. He opposed the dogma of papal infallibility, and in connection with this subject wrote on 'The Condemnation of Pope Honorius' (1868) and 'The Case of Pope Honorius Reconsidered' (1869). From 1866 till 1885 he was an inspector of schools, and during 1885–91 he was keeper of the Egyptian and Assyrian antiquities in the British Museum. In 1875 he published 'An Elementary Grammar of the Ancient Egyptian Language' (2d ed. 1896), and in 1879 delivered a course of Hibbert lectures on the 'Origin and Growth of Religion as Illustrated by the Religion of Ancient Egypt' (1880; 2d ed. 1884). He was knighted in 1896 for distinguished scholarship. He left unfinished a translation of the 'Book of the Dead,' with commentary, which at the time of his death was in course of publication (1892 et seq.) in the 'Proceedings' of the Society of Biblical Archæology, of which he was president from 1887. The work was completed from Renouf's notes by E. Naville. Renouf was one of the most careful and trustworthy Egyptologists of his time, and, besides, a most versatile linguist. For a sketch of him, with a bibliography of his writings, consult the 'Proceedings' of the Society of Biblical Archæology (Vol. XIX., 1897).

Renovo, rē-nō'vō, Pa., borough in Clinton County; on a division of the Pennsylvania railroad; about 125 miles northeast of Pittsburg and 25 miles northwest of Lock Haven. It is in a region of the Alleghany Mountains noted for grand scenery, and an abundance of game. Renovo is a summer resort which is growing in favor. It has considerable industrial interests connected with the extensive bituminous coal-fields and the fire-clay deposits in the vicinity. The chief industrial establishments are the Pennsylvania railroad shops, the coal yards, and the brick works. Pop. (1910) 4,621.

Rensselaer, rĕn'sẹ-lėr, Ind., city, county-seat of Jasper County; on Iroquois River, and on the Chicago, Indianapolis & Louisville railroad; about 100 miles northwest of Indianapolis. It was settled in 1834 by David Nowles, John Nowles, and Joseph Yeoma. It was incorporated in 1850, and chartered as a city on 1 May 1896. Rensselaer is in an agricultural region; and its manufacturing industries are chiefly connected with farm products. It ships considerable farm produce and live-stock. There are five churches, a high school, public elementary schools, and business schools. The four banks have a combined capital of $100,000, and the annual amount of business is $3,000,000. The government is vested in a mayor and a council of six members elected biennially. Pop. (1890) 1,455; (1900) 2,255; (1910 est.) 2,600.

Rensselaer, N. Y., city in Rensselaer County; on the Hudson River, and on the Boston & A., and the New York C. & H. R. R.R.'s; opposite Albany and six miles south of Troy. It is connected with Albany, Troy, and other cities by electric lines; and it has connection by steamboat with many of the cities and towns on the river. Three large bridges span the Hudson and connect Rensselaer with Albany. The first settlement was made by the Dutch. It was incorporated as a village in 1815 and in 1897 was chartered as a city. It was called Greenbush until it became a city, when it took the name Rensselaer. The village of Bath was annexed in 1902. Rensselaer is a commercial and manufacturing city. The chief manufacturing establishments are a felt factory, tannery, aniline works, and shirt-waist factory. A large number of persons are employed in connection with the railroads and steamboats, and in the offices, stores, and manufactories in Albany and Troy. There are 10 churches, two public schools, one parish school, Saint John's Academy, and Saint John's Orphan Asylum. The government is vested in a mayor and a common council of 10 members, elected biennially. Pop. (1900) 7,466; (1910) 10,711. The addition of Bath increased the population of the city about 3,100.

Rensselaer Polytechnic Institute, located at Troy, N. Y. It was founded by Stephen Van Rensselaer in 1824 as a school of practical science, being the first school of science and the first school of engineering to be established in any English-speaking country. It was first opened to students in January 1825, and incorporated in March 1826. It was at first named the Rensselaer School; afterward the Rensselaer Institute, and finally the Rensselaer Polytechnic Institute. Lectures on land surveying and engineering were given as early as 1823; and after 1850 the Institute became more distinctly a school of civil engineering; the course at that time was lengthened from one year to three years. It now offers two courses of four years each, one in natural science and one in civil engineering. These courses include instruction in chemical analysis, mineralogy, metallurgy and assaying, as well as in the design and construction of roads, railroads, bridges, roofs, arches, dams, steam engines, electric engines, dynamos, turbines, foundations, waterworks, tunnels, sewers, and canals. The degrees of B.S. and C.E. are conferred. The students in 1910 numbered 626, and the faculty 53. Its influence has been widespread. Students have come to it from 42 of the States of the Union and 25 foreign countries, and its graduates are at present practising their profession in 45 of the States and 19 foreign countries. Its standing as a professional school is shown by the following extract from the report to the German government by Professor A. Riedler of the Royal Polytechnicum of Berlin: «The greatest number of renowned hydraulic and railroad engineers of America are graduates of this school.»

PALMER C. RICKETTS,
Director of the Rensselaer Polytechnic Institute.

Rents, Law of. Rent has been defined as a certain profit, in money, provisions, chattels or labor, issuing out of lands and tenements in retribution for their use; or. rent is a definite compensation reserved by lease, to be made periodically, and payable in money, produce, other chattels, or labor, for the possession and use of land and tenements. Where one person occupies land or premises of another under an agreement, express or implied, there exists the relation of landlord and tenant. The landlord is a person whose lands are occupied and the tenant is one who occupies same. A sub-tenant is one who leases all or part of the premises from the original tenant. The relation of landlord and tenant is generally created by a lease, although it may exist without an agreement and without liability on the part of the tenant, and may arise by implication if the acts of the parties are consistent with it. The terms lessor and lessee respectively, designate the landlord and tenant. A lease is a contract by the owner of lands or tenements on one side, with one who is to pay a rent or income for its use; it differs materially from a license, which is merely a permission to perform some act with respect to land belonging to another; mere occupancy of land under an agreement to cultivate it for a share of the crops does not establish the relation of landlord and tenant; whether or not such relation may exist in some cases depends on the intention of the parties. A tenant continuing to occupy premises without the consent of the landlord, and after the term of his lease has expired is a tenancy at sufferance, which may be terminated at the will of the landlord, or by a new tenancy, either express or implied. Where premises are leased to be occupied for such time as may be desired by the other party, it is termed a tenancy at will; such a tenancy exists when one occupies premises with the owner's permission without paying rent.

Tenancy at will is held to exist in the following cases: where one takes possession under a conveyance, lease, or contract for sale, that is invalid; or where one takes possession while negotiations are pending for a lease, or for purchase, and where one takes possession under an agreement for a lease. Statutes in some jurisdictions hold that a tenancy not governed by a lease is a tenancy at will. A tenancy at will may be terminated where the landlord leases the property to a third person for a term of years, by the death of either the landlord or tenant, by the sale of the property, or by any act on the part of the landlord amounting to a demand for possession or showing such intention. In some jurisdictions statutes require a formal notice. A tenant at will, unless it is distinctly stipulated to the contrary, is liable for a fair rental of the premises. The lessee is liable for the rent agreed upon, whether or not he takes possession; it has been held by a number of courts that an exception to this is where the premises are destroyed before the beginning of the term. Unless contained in the agreement, a landlord is not compelled to make repairs, nor is he liable for them, or any injury caused by the condition of the premises,—not even if the repairs are on account of injury by adjoining buildings. Where buildings are destroyed by fire or accidental cause, the landlord is under no implied obligation to rebuild them; if he does so, however, the tenant is entitled to occupy the new building. Where one rents part of a building, it is generally held that the landlord is under no implied obligation to keep any other part of such building in repair. Landlords are generally liable to tenants for injuries due to accidental defects, and for any negligence on his part, in relation to a part of the building occupied by another tenant, or a portion thereof, that is under his control, and is obliged to keep in repair the portion that is rented, but is under no obligation to one tenant to repair a part of the building leased to another tenant. It is an implied duty on the part of the landlord to keep passageways and approaches used by several tenants, in repair; but, unless so required by the law, or his contract, he is not obliged to keep the passageways lighted. It is also his duty to prevent any obstruction of a passageway, which would make it dangerous, and it has been held that it is a landlord's duty to remove accumulations of ice and snow.

It is held in some jurisdictions that where a building is rented to a number of tenants, it is the duty of a landlord to keep water pipes in repair and that he is liable for any negligent use, through himself or his agent, or servants, of the water, but not for the negligence of another tenant. Notice must be given to a landlord of defects in the premises in order to render him liable for negligence in relation thereto. Generally a landlord is liable for concealing dangerous defects on the premises. An agreement to make repairs does not require the landlord to include such repairs as may be necessary from the carelessness of the tenant; on failure to make repairs in accordance with an agreement, the tenant can make the repairs and recover the cost from the landlord or bring an action on the contract and if the premises become untenantable for the want of repairs the tenant may abandon the premises; a tenant must make a demand for the repairs in order to entitle him to any remedy. Repairs made by the landlord must be executed with care, and he is liable for any injury that may occur therefrom. Where premises that are in proper condition at the time of being rented, are allowed to come in a dangerous condition, a tenant is as a rule liable for injuries, such as may occur from falling roof, or defective sidewalk. It is a principle well established that a tenant cannot dispute a landlord's title except when the landlord was induced by fraud or misrepresentation to become such. An action at law at any time can be maintained by the landlord, or his assignee, to recover rent, and under ordinary circumstances no prior demand is necessary; in many jurisdictions a landlord is authorized to attach the property of a tenant. The various matters and things concerning the renting of property, and the relations of landlord and tenant, have been made the subject of statutes in some jurisdictions, and vary the general laws and customs governing these subjects.

Henry M. Earle.

Renuncia'tion, in law, the act of giving up a right, such as the position of an executor or administrator of an estate, or any other office, charge or claim to which the person renouncing is legally entitled. There are proper legal forms for such action.

Ren'wick, Edward Sabine, American engineer and patent expert: b. New York 3 Jan. 1823. He was graduated from Columbia in 1839 as a civil and mechanical engineer and became superintendent of large iron works at Wilkesbarre, Pa. In 1849 he began his career as a patent expert and in 1862, with his brother Henry Renwick, he repaired a break 82 feet long and 10 feet wide in the bilge of the Great Eastern while afloat, a feat deemed an impossibility by experts. He invented several machines and mechanical appliances and published 'Practical Invention' (1893).

Renwick, James, Scottish covenanter: b. Moniaive, Dumfriesshire, Scotland, 15 Feb. 1662; d. Edinburgh, 17 Feb. 1688. He was educated for the ministry at the University of Edinburgh, but upon declining to recognize Charles II. as the head of the Church was refused a degree. He finished his education at Groningen, Holland, was ordained in 1683, returned to Scotland, and engaged in preaching at conventicles. He was outlawed in 1684 as a result of publishing with Alexander Shields 'An Informatory Vindication of the Covenanters.' In 1687, as the acknowledged leader of the Cameronians, a price was put upon his head. He was captured in the following year and executed at Edinburgh.

Renwick, James, American scientist: b. Liverpool, England, 30 May 1790; d. New York 12 Jan. 1863. He came with his parents to New York in 1794, was graduated from Columbia and in 1812 acted as instructor in natural philosophy there. In 1814 he became a topographical engineer with rank as major in the United States service and in 1820–53 was professor of chemistry and physics at Columbia. In 1840 he was engaged as one of the commissioners to survey the boundary line between United States and New Brunswick. His publications include: 'Treatise on the Steam Engine' (1830); 'Outlines of Geology' (1838); 'Applications of the Science of Mechanics to Practical Purposes' (1840); 'Memoir of De Witt Clinton' (1840); etc.

Renwick, James, American architect: b. New York 3 Nov. 1818; d. there 23 June 1895. He was son of the preceding, and was graduated at Columbia College in 1836. Among his many works are Grace Church, New York, completed in 1845; the Smithsonian Institution and the Corcoran Art Gallery, Washington, D. C.; Vassar College, Poughkeepsie; and Saint Patrick's Cathedral, New York. This list of buildings evidences the versatility of this truly learned architect, whose mastery of French Gothic, both in its details and proportions, enabled him to give New York two of the noblest ecclesiastical exteriors in the city.

Repairs. See Law of Landlord and Tenant.

Reparative Surgery. See Surgery.

Repeal Movement, the agitation for the repeal of the Union between Great Britain and Ireland. This agitation commenced almost at the moment of the Union, and has continued to the present time. Robert Emmet sacrificed his life to the cause of repeal in 1803. But the word repeal is most intimately connected with the name and career of Daniel O'Connell, the Irish "Liberator." O'Connell died in 1847, and the cause of repeal was taken up by the Young Ireland party of 1848; by the Fenians, whose operations came to a head in 1865–7; and finally by the Home Rule party organized under the leadership first of Isaac Butt, in 1870, and later under the leadership of Charles S. Parnell. During the celebrated Parnell Commission of 1888–9, however, the Home Rule party, through their counsel, disclaimed all desire for repeal, maintaining that their aims were confined to the obtaining of Home Rule in the strict, or restricted, sense of the word.

Repeater, in arithmetic, an indeterminate decimal in which the same figures continually recur or are repeated. A pure repeater, or circulating decimal, is one in which the repetition goes on from the beginning; as, .3333 . . . .272727 . . . A mixed repeater is one in which the repetition does not begin till after the intervention of a figure or figures; as, .128888 . . ., .0113636 . . ., etc. (For the algebraic method of finding the value of a repeating decimal see Progression.)

In firearms, an arm which may be caused to fire several successive shots without reloading, whether rifle, pistol, or cannon. In horology, a watch or clock made to strike the time when a spring is pushed in. Some strike the hour and quarters, others the hour, quarter, and odd minutes. Nautically, a vessel, usually a frigate, appointed to attend each admiral in a fleet, and to repeat every signal he makes, with which she immediately sails to the ship for which it is intended, or the whole length of the fleet when the signal is general; called also a repeating ship. In telegraphy, the same as relay.

Repentance, or **Contrition,** as understood by divines, both Protestant and Catholic, is defined by the Council of Trent as «grief of mind and detestation of sin committed, with a purpose of sinning no more»; more specifically it is that sorrow for sin which arises out of consideration of God's goodness which sin has outraged, and which includes a resolution never more to offend God because God so deserves our love: this is the repentance called by Protestant divines «godly sorrow.» The same Protestant divines recognize a second kind of repentance, which mourns that sin is attended by a penalty rather than hates sin. This differs little from the «attrition» of Catholic divines, which is an imperfect sorrow for sin arising from such motives as fear of hell, loss of heaven, the turpitude of sin.

Reporting. See JOURNALISM; NEWSPAPERS.

Repoussé, rê-poo-sā, a kind of ornamental metal work, formed in relief by striking on the metal from behind with a punch or hammer till the required forms are roughly produced in relief on the surface; the work is then finished by the process of chasing. The work of Benvenuto Cellini (1500–70), in this branch of art, is the most celebrated. Common work of this kind, as for tea or coffee pots, is executed in pewter and Britannia metal, and then electrotyped.

A piece of heavy cotton lace, or heavy openwork fabric, or a piece of a basket may be glued to a block of hard wood to serve as a sort of die for producing the impression in the metal. The fabric or basket work is not only attached to the block by means of glue, but its finer interstices are filled with glue, so as to present a surface resembling the original fabric only in the most general way. When the glue is perfectly dry and hard, the die is laid on a solid foundation, and a piece of very thin, soft copper or brass is secured to the block so as to cover the lace. A piece of cork about one fourth inch thick and about three inches wide and six or eight inches long is laid over the metal, and struck with a mallet. The cork yields sufficiently to push the metal down on the die, and cause it to take the pattern of the lace or whatever is used in forming the die. A piece of rather hard rubber packing will answer this purpose in nearly all respects as well as the cork.

Designs may be cut from strong paper or pasteboard and glued to the block, or a stencil design may be sawed from hard wood. The lines and scrolls are discontinued in places, so as to cause the wood to hold together. If it is desired to render the lines continuous at these points, they may be run through with a V-tool. Dots are picked out with a small gouge or the point of a revolving drill. In all these cases the metal is attached to the block and treated as above.

Either panels or continuous strips may be embossed in the manner described, and these are to be used in making frames, vases, and various ornamental objects. If the metal is too thin for a certain case, it may be strengthened by flowing soft solder over the back of the plate by means of a soldering iron. As to finish, any of the several well-known methods of oxidizing or lacquering may be employed.

Bas-reliefs may easily be made by a method which is a modification of the one described. To a wooden frame is fitted a board, on which is drawn in outline the sign which is to be produced in relief. The board may be of pine or any close-grained, soft wood for lead work; but for brass or copper, the wood should be hard. To the frame is attached the plate of metal by means of screws. The board is removed from the frame, and the portion of the design which is to form the most prominent feature of the relief is sawed out of the board, when the latter is replaced in the frame, and the metal is forced into the opening of the board by pressing on the surface of the lead opposite the hole in the board, or by pounding it by means of the mallet. As soon as this feature is complete, the next in order is sawed out of the board, and the operation is repeated till all of the general features are developed. The progress of the work can be observed at any time by removing the board.

The features may be corrected or modified by working from either side of the plate by means of the convex mallet and the wooden punches and chisels. If a support is desired for any part while the work is progressing, a stout bag filled with sand may be placed under the part. A few very small bags, say 1 inch or 1½ inches, in diameter, will be found convenient. If desired, the drapery of the background may be chased by means of hard wood or metal punches, bearing the desired figures.

The relief, if of lead, looks well with an antique finish. This may be secured by rubbing the prominent portions of the relief with fine emery cloth, then going over the entire surface with a swab formed of a small roll of cotton cloth encircled by a coil of copper wire, the swab being dipped in dilute nitric acid before application to the relief.

The copper is dissolved and deposited on the bright prominent portions, while a dark deposit is made in the hollows, which when dry has a green tinge.

To give the work the appearance of antique iron the surface may be blackened by the application of a solution of sulphuret of potassium and the prominent portions may be semi-polished by briskly rubbing the entire surface with a piece of canvas or Brussels carpet.

Repplier, Agnes, American essayist: b. Philadelphia, Pa., 1 April 1855. She is of French descent, and was educated at the convent of the Sacred Heart, Torresdale. Her essays are characterized by lightness of touch, a keen sense of the humorous side of a theme, and not a little irony. She has published: 'Books and Men' (1888); 'Points of View' (1892); 'In the Dozy Hours' (1894); 'Essays in Idleness' (1893); 'Essays in Miniature' (1892); 'Varia' (1897); and 'Philadelphia: the Place and the People' (1898); 'The Fireside Sphinx' (1901). She has also compiled a 'Book of Famous Verse' (1892), and was a contributor to the 'Saturday Evening Post.'

Representative Government. Representative government in the modern meaning of the term was unknown to the ancients. Kings, chiefs, and administrative officers were often elected by popular vote or acclamation, but neither in ancient Greece nor Rome did a body exist even remotely resembling a Congress, a Parliament, or a Reichstag. States which were not absolute despotisms were governed, as a rule, by a council of magistrates and a popular assembly, in which latter all persons with civic rights took part, and which was very much like a New England town meeting; but there is no instance of the popular assembly of ancient times developing into a representative body. The Roman Senate was composed of magistrates and ex-magistrates, and resembled the American Senate of to-day only in name. This ancient system, which appears from the standpoint of to-day both unwieldy and unruly, was well enough fitted, however, for the so-called republics in which it prevailed, and in which all power was reserved to the central city, whether Athens, Thebes, or Rome. The citizens in public assembly stood for the state, and were the state, and did not think it necessary to delegate their powers to representatives. When civic rule in Rome gave place to imperialism, the public assembly ceased to exist, while the senate was retained to register the decrees of the Cæsars, and offer honorable retirement to those who had gained imperial favor.

Representative government, as we know it to-day, is not derived, therefore, from any Roman or Greek institution. It is essentially an outgrowth of that love of liberty inherent alike in Saxon and Norman, and reached its present development through centuries of struggle and of political and social evolution. The English Parliament, with its combination of mediæval House of Lords and 20th century House of Commons, has grown gradually from beginnings dating back almost to the Norman conquest. The barons asserted their rights against tyrannical kings, and the necessities of the kings compelled them to recognize the well-to-do classes outside the nobility, who had the wealth of which the royal exchequer stood badly in need. Taxation gave birth to representation, and at length it became a recognized principle that Englishmen would not stand taxation imposed without their own consent through representatives in Parliament assembled. It was not, however, until far into the 19th century that the common people of England were permitted to have a voice in public affairs, and not until 1885 that the suffrage was bestowed on virtually all male subjects of adult age in the United Kingdom. The Parliament of to-day therefore represents the English people; less than half a century ago it represented only the privileged classes.

Representative government in the United States inherited its spirit from England, but not its form. The American system is of native origin. It developed from town-meeting to assembly, and when the new States adopted new fundamental laws, the upper house was called a senate, after the ancient Rome senate, while the right of originating measures of taxation was reserved to the popular branch of the legislature. In the United States, also, however, the right or privilege of voting was generally restricted to taxpayers and property-owners for many years after independence, and in one of the States — Rhode Island — a landholding qualification for foreign-born citizens existed until about 15 years ago. Excepting some peculiar restrictions intended to prevent negroes from voting in certain Southern States, nearly all male citizens of adult age now possess the right to vote.

In the Hanseatic towns, in Switzerland, the Italian free cities, and other republics of the Middle Ages, representative government had no real existence so far as the common people were concerned, and the parliaments of modern Europe are not derived from the institutions of those states. The American Revolution gave the impulse and inspiration needed to awaken the people of Europe to a sense of their rights and wrongs, and the constitutions granted by monarchs on the Continent to their subjects adopted as models a mixture of the English and American systems. With the exception of Turkey and Russia every European country has a congress or parliament in which the people are represented by deputies elected according to law. Japan has a similar system, and representative government which 100 years ago was practically confined to the United States and England, is now co-extensive with civilization in every continent. See GOVERNMENT.

Representatives, House of, the designation applied to that branch of the Congress of the United States elected directly by the people, and also applied in several States to the lower body of the State legislature. The Constitution of the United States vests in the House of Representatives the sole power to originate measures affecting taxation and finance, although the Senate has the right to amend such measures when passed in the Lower House, and it sometimes happens that a financial bill adopted by the House is virtually made a new measure in the Senate, and thus amended is accepted by the House, and becomes law. As tariff legislation is one form of taxation, it originates in the Committee on Ways and Means of the House, and the chairmanship of that committee is, therefore, a place of great power and importance. When the House and the Senate cannot agree, a Conference Committee is appointed from both bodies to adjust the differences, if possible. See CONGRESS OF THE UNITED STATES.

Reproaches, or **Improperia** (a Latin word of the same meaning), in the Roman Missal, a part of the divine service for Good Friday. While the clergy and people are paying veneration to the representation of the Crucified before the high altar, two pair of choristers chant alternately a series of antiphons, to which two choruses respond in versicles, Greek and Latin alternately, then repeating part of the antiphon. There are 12 Improperia, the first being: «My people, what have I done to thee? or wherein have I vexed thee? For that I led thee forth of the land of Egypt thou has provided a cross for thy Saviour.» Again: «I lifted thee up with mighty power; and thou hast hanged me on the gibbet of the cross.»

Reproba'tion, a dogma of the Calvinistic creeds, which teaches the predestination of some of the children of Adam to be eternally lost. Though the word reprobation is not used in the Westminster Confession of faith, the definitive reprobation of those who are not predestinated to everlasting life is unequivocally expressed in this passage of the Confession (iii. 7): "The rest of mankind" — that is, all but the elect to everlasting happiness — "God was pleased, according to the unsearchable counsel of his own will, whereby he extendeth or withholdeth mercy as he pleaseth, for the glory of his sovereign power over his creatures to pass by, and to ordain them to dishonour and wrath for their sin, to the praise of his glorious grace." Among the passages of the New Testament that are cited in support of this doctrine are Rom. ix. 11–22, 1 Thess. v. 9, 1 Pet. ii. 8, Jude 4.

Reproduction, among plants and animals, is, in a broad sense, the formation by any means of new persons or individuals to continue the life of the species. According to a more strict usage, reproduction is to be distinguished from propagation, which is generally confined to the production of new persons by the development of parts of some old individual, as for example, a branch of a tree, a polyp of a coral colony, or a portion of a certain species of worm. In all essential respects such a branch or polyp or worm-segment is an individual: the entire tree or coral-colony is considered to be a compound individual. The budding and branching of common plants and of many animals is really a production of new individuals. Single branches or twigs of almost all branching plants, cut off and planted under suitable conditions, will take root and become new individuals; the only difference between such an individual and a branch of a living tree is that in one case the new person and the old are separated, whereas in the latter the new individuals remain continuous with the old. Huxley used the terms *continuous growth* and *discontinuous growth* to designate these two conditions, the idea being that all the structures derived from a single egg constitute a single individual, whether continuous or not. According to this view all the weeping willows constitute collectively one individual, however many separate trees there may be, since this plant produces no seeds, being propagated by cuttings. The same would apply to other cultivated plants which have lost the habit of producing seeds. It is thus seen that propagation is but a development of *growth;* and all reproduction is a development of this property of protoplasm.

Propagation among Plants.— Among the unicellular plants, a common mode of multiplication is by *fission,* or the separation of the cell into two parts, each of which becomes an independent (though in many cases attached) individual, eventually to split up in its turn, and so on indefinitely. Among others (*Schizomycetes*), as the yeast plant, there is a process of *gemmation* or budding of the parent cell; the buds split off, or may remain attached, but really constitute independent units. Among the mosses, almost any part of the plant body will develop into a new individual when separated and placed under the proper conditions, and portions are frequently separated spontaneously for this purpose. The root-stock in ferns is a propagating organ, and the tip of the leaf in the walking fern will take root and produce an entire plant, while the part of the leaf connected with the old plant dies away. Some liverworts produce small masses of cells called gemmules which are thrown off and may develop into new plants. Among the flowering plants are found many special means of propagation. The runner of the strawberry plant is a well known example; this is a prostrate branch which, at some distance from the parent plant, takes root, sending up a stem vertically, while the runner dies away; by this means one strawberry plant may extend itself in a single season over a large area. Some plants produce aerial bulbs, which are thrown off and may develop into new plants, as the onion. Underground stems, such as the tuber (as of potato), the root-stock, (as of iris), and the bulb (as of hyacinth), also serve for propagation, spontaneous or artificial. The leaves of many flowering plants, when separated from the parent stem, put forth adventitious roots and buds (such as arise in unusual places), which develop new plants. Begonia and byrophyllum are commonly propagated in this way. Many weeds are eradicated with great difficulty because of the fact that each piece into which the farmer's spade cuts the obnoxious plants grows into a new plant.

Propagation among Animals.— Among the *Protozoa,* multiplication by fission is the common method, though this is generally supplemented by occasional conjugation of two individuals. Among certain *Infusoria* budding also occurs. Among sponges, cœlenterates and Bryozoa budding is the process that gives these animals their characteristic colonial formation. When an individual hydroid is mutilated by a portion being cut off, each part may proceed to develop what it lacks of being a complete individual. Among the echinoderms the starfish has the property of regeneration developed to such a remarkable degree, that a single ray of one may develop into an entire animal. Many flat-worms, round-worms and annelids have the faculty of letting each piece into which an individual may be cut up develop into a new individual, and some of them have the means and the habit of breaking up spontaneously. While many arthropods and even some vertebrates have the power to re-grow lost parts, in none of the higher groups of animals are there any capable of propagation by means of cuttings.

Reproduction Proper.— Reproduction proper is the multiplication by means of some structures specially formed for that purpose, and is of two kinds,— sexual and asexual. In asexual reproduction the bodies formed, called *spores,* are capable of developing directly into new individuals, while in sexual reproduction two reproductive bodies, called *gametes,* must first fuse together before development may begin.

Spores are produced by all plants except a few of the lower ones and such aberrant forms as have lost the habit of reproduction by special structures, and by certain of the lower animals. They consist usually of single cells having a thickened wall for protection against dessication and other injury, and containing oil-drops or other stored-up nourishment. Plant spores are generally too small to be seen by the unaided eye, but in masses resemble so much dust, as seen in the pollen-dust of various flowers, in the dust of puff-balls, bracket-fungi, etc. Many *Algæ* and *Sporozoa* produce spores that bear cilia which enable them to move about in the water; these are called zoöspores.

Spores are formed in three different ways: (1) By condensation of the protoplasmic content of some cell, with the formation of a special cell-wall (chlamydospores in *Mucor*, or the mass of protoplasm may escape and swim about for awhile by means of cilia, before forming a thick coat and passing through a resting stage. (2) By the splitting off of the end cells in filaments, singly or successively, these cells becoming spores, as in green-molds, red sea-weeds, puff-balls and mushrooms. (3) By the breaking up of the contents of special cells (spore-mother-cells) into few or many portions, each of which becomes a spore, as in black-mold, yeast, lichens, mosses, ferns and all spermatophytes. Animal spores are of this third type. A vegetable spore on germinating usually puts forth a delicate thread from which the plant of the next generation develops. In the lowest plants, as among the *Sporozoa*, the spore merely breaks out of its wall and changes directly into the next stage.

Sexual Reproduction.— Of sexual reproduction there are several degrees. The simplest form is *conjugation*, in which the two gametes are not only exactly alike, but are actually two entire individuals. This is well illustrated by the pond-scum and the various diatoms and desmids. Two individuals of some species of desmid will approach each other, and after coming in contact the cell-wall of each, on the side next its neighbor, will be dissolved and the protoplasm from the two cells will flow out and the two masses fuse into one, which, after forming a thick wall and resting for a period, will become a new free-moving individual. Essentially the same method is seen in black-mold and in other plants, while in *Spirogyra* the contents of one cell passes over into the other cell, where the two masses fuse. The product of the conjugation of two gametes which are, as in the cases given, essentially alike, is called a zygote; but among the lowest classes of plants and animals there already arises a differentiation between the gametes into the male ***spermatozoön*** (or antherozoïd), and the female ovum. The process of fusion of the two differentiated gametes is called fertilization or fecundation of the egg or ovum, and the product is known as the fertilized ovum.

Alternation of Generations.— Among the liver-worts, mosses, ferns and phanerogams, as well as among certain groups of animals, there is found the phenomenon known as "alternation of generations," called by Spencer ***heterogenesis***. The sporophyte, or that stage in the life-history of the plant which produces spores, does not at all resemble the gametophyte, or gamete-producing generation; moreover, the spores develop only into gametophytes, while the fertilized eggs develop only into sporophytes, thus bringing about an alternation of the sexual generation with the asexual generation.

The ordinary green plant of a liverwort or a moss is the gametophyte, producing archegonia in which the ova are formed, and antheridia in which antherozoïds are formed. The antherozoïds are discharged into the water and find their way into the archegonia, and fertilize the eggs in these. From the egg the sporophyte develops directly, being in the case of the mosses the "capsule" with its stalk. In the capsule the spores are produced, and after being thrown out each of these may germinate and develop into a gametophyte. In the ferns, the familiar stage is the sporophyte; the spores, produced in groups of spore-cases or sporangia on the under surface of the leaves, or on special modified leaves, may develop, under suitable conditions, the sexual generation, or prothallium, which is a very inconspicuous, heart-shaped plate of cells, rarely over one fourth inch in diameter, bearing archegonia and antheridia on its under surface; after fecundation, the egg develops into the familiar sporophyte.

Among some of the ferns, and in all of the higher plants, two kinds of spores are formed; a large spore, the gametophyte developing from which produces only female gametes; and a small spore resulting in a gametophyte producing only male gametes. Among the flowering plants the difference between the sexual and the asexual generations is so great that one of them is very commonly entirely overlooked, even in such well known text-books as Gray's. All the trees, flowering shrubs and herbs, grasses, etc., are sporophytes, and the two kinds of spores are the pollen and the embryo-sac of the ovary. In these highest plants the male gametophyte is reduced to the pollen tube, which grows down from the stigma, into proximity of the ovule. The female gamete is still farther reduced. The male gamete is a special portion of the protoplasm in the end of the pollen-tube, while the female gamete is a special portion of the protoplasm in the embryo-sac. It is to be noted that whereas in the mosses and liverworts the sporophyte derives the bulk of its nutrition from the gametophyte, among the phanerogams the male and female gametophytes are parasitic upon the sporophyte, which does all the vegetative work. After fertilization the embryo of a new sporophyte generation is developed at the expense of the preceding sporophitic generation. This embryo is the essential part of the ***seed***. The popular reference to seeds as reproductive organs or structures, and to the anthers and ovaries of flowers as respectively male and female, is manifestly false.

Purpose of Reproduction.— Reproduction of organisms seems to be an outcome of the fact that conditions of life are variable; for various reasons immortality of the individual is impossible, and continuation of the life of the species can therefore be secured only by multiplication of individuals. This theory is in harmony with the observed periodicity of the reproductive processes, as well as with the fact that the reproductive processes may be hastened or retarded by artificial control of the conditions. See Anatomy; Anatomy, Comparative; Embryology; Sex.

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Reproductive Organs. See ANATOMY, COMPARATIVE.

Reptiles, or **Reptilia,** a class of vertebrated animals. Although no two groups of *Vertebrata* are more dissimilar in general appearance and habits, and to the popular mind might seem more unrelated than the birds and reptiles, they are, by common consent of modern systematists, combined in a superclass, the *Sauropsida,* of Huxley, or the *Monocondylia,* of Haeckel and Cope. The *Sauropsida* are distinguished by the possession of lungs, gills being permanently absent. The embryo possesses an amnion and allantois, the former being a sac investing the body, the latter a structure developed from the lower surface of the embryo, and serving for respiration. The lower jaw in *Sauropsida* is compound in that each half or ramus consists of a number of distinct pieces; while in mammals each half consists of but a single piece. The lower jaw in reptiles and birds further articulates with the skull, not directly, but through the intervention of a separate and distinct bone, the os quadratum or quadrate bone. The skull is joined to the spine by one condyle only, borne on the occipital or hinder bone of the skull; two such condyles exist in amphibians and mammals. As compared with the fishes and batrachians the basal axis of the brain-case is bony instead of cartilaginous and the parasphenoid bone is absent. The bodies of the vertebræ are formed chiefly of centra (that is, are gastrocentrous) instead of intercentra (notocentrous) as in the *Amphibia.* Very rarely and only in extinct forms is the notochord persistent. The ankle-joint is placed in *Sauropsida,* not as in mammals, between the tibia and the astragalus, but between the proximal and distal parts of the tarsus which in *Sauropsida* becomes thus divided. The coracoid bone is almost always well developed. The intestine ends in a cloaca. No complete diaphragm is developed to separate the thorax from the abdominal cavity. The corpus callosum uniting the halves or hemispheres of the cerebrum is rudimentary, no mammary glands exist, and the *Sauropsida* are oviparous or ovo-viviparous. The red blood-corpuscles are oval and nucleated. Such are the characters common to birds and reptiles.

Reptiles differ from birds in the following characters, which may therefore be taken as including the definition of the class Reptilia. The exoskeleton consists of horny scales or of bony plates (scutes), but never of feathers. The blood is cold, and two aortic arches (right and left) exist in living *Reptilia.* The heart is three-chambered in all save the crocodiles, which possess a four-chambered heart. But in all reptiles, without exception, the venous and arterial currents of blood are connected, and an impure or mixed blood is thus circulated throughout the body. The lungs do not present the open character of those of birds, but, like those of mammalia, are in modern reptiles almost always closed sacs. The tarsal and metatarsal bones of the hind limbs, which in birds are united to form a single bone, are distinct and separate in the great majority of reptiles. When a sacrum exists it bears sacral ribs, which articulate with the ilia or haunch-bones.

The body in reptiles is generally elongated, the tortoises and their allies presenting the most notable exceptions to this rule. The limbs may be entirely wanting, as in most snakes and in many lizards; or only a pair of limbs may be developed, as in some lizards; while in most other reptiles all four members are present. The exoskeleton varies greatly in its development throughout the class. As in the tortoises and turtles and crocodiles it may attain, either separately or in combination with the endoskeleton, a high development, with superficial deposits of bone. In serpents and many lizards it is moderately developed and chiefly horny, while in some lizards the skin is comparatively unprotected. The bones of reptiles are more compact than those of lower vertebrates, and it is also notable that in reptiles the sutures, or lines of union between various bones, have a degree of persistence beyond that in other classes of the phylum. In the reptilian skeleton the five different regions into which the spine is ordinarily divided are to be recognized, except in the serpents and a few others. There are seldom more than two sacral vertebræ, and free cervical ribs are usually present. The epiphysial and other sutures of the vertebræ are retained through life. The bones of the shoulder-girdle of each side include a simple or divided scapula or shoulder-blade and an often complex coracoid bone, including precoracoid and epicoracoid, the latter bone of each side articulating with the sternum or breast-bone when the latter is present. In addition a clavicle and interclavicle may be present. The fore-limbs consist each of a humerus, radius, and ulna, the carpal bones, and normally five digits. The pelvis contains its three typical elements, ilium, ischium, and pubis, the first being often of larger size and the last usually forming a symphysis. In serpents the shoulder-girdle is totally absent and vestiges of the pelvic-girdle appear only in a few instances; and in the turtles both are enclosed within the shell, except that the clavicle and interclavicle form part of the plastron. The limbs are usually adapted for running, but sometimes for leaping and in the extinct pterodactyls for flight. In the extinct marine pelagic reptiles, and in the modern sea-turtles, they are paddle-like. The ribs in reptiles are always present, but may differ greatly in form and disposition, those of the turtles, for example, contributing toward the formation of the upper shell or carapace.

The skull of *Reptilia* possesses but a single occipital condyle, by means of which it articulates with the spine. This condyle is formed by the basi-occipital and ex-occipital elements of the cranium and is sometimes tripartite. The quadrate bone is generally firmly fixed to the skull, joining the squamosal bone above, but is freely movable in serpents and only less so in many lizards. Each half or ramus of the lower jaw is composed of dentary, angular, surangular, coronoid, splenial, and articular bones. Other regions of the skull are modified in the greatest varieties of ways in the several orders, the most important from a systematic standpoint being in the bones which form the complex roof of the temporal fossa. Primitively this roof is complete as in the stegocephalian batrachians, but by the formation of one or two openings (supra- and infra-temporal vacuities) it is divided into one (*Synapsida*) or two (*Diapsida*) longitudinal bars behind the orbits. Through variations in the size and position of these openings, to which may be added emarginations, this region is modified, and may even practically disappear altogether, as in the snakes.

The teeth are generally well developed, but in the *Chelonia* are wanting, the jaws, like those of birds, being ensheathed in horn. The reptilian teeth, like those of lower *Vertebrata* generally, are adapted less for mastication than for merely retaining prey while it is being swallowed. Save in the crocodiles and in some extinct forms the teeth are not implanted in sockets or *alveoli,* but are attached in various ways and by bony union to the jaw-bones. Teeth may be borne by bones other than the jaws (for example, palate bones); and, as seen in the poison-fangs of serpents, may be modified for special purposes. The teeth vary greatly in number and are not persistent, new teeth being produced in regular order (as in crocodiles) from a growing pulp at the base of the socket, the new tooth displacing the old.

The tongue may be elongated, distensible, and bifid, as in many lizards and serpents; short, thick, and non-protrusible, as in other lizards; or completely attached and fixed throughout its entire extent, as in *Crocodilia.* The œsophagus or gullet is usually greatly distensible (as in serpents), and may be covered (as in some *Chelonia*) with retroverted spines. The stomach is mostly pyriform or pear-shaped, and (as in snakes) may, like the gullet, be capable of great distension. In *Ophidia* it exhibits an anterior dilated part, with thin walls for receiving nutriment, and a posterior hinder portion with non-distensible walls provided with glands, and adapted for digesting the food. In the crocodile the stomach resembles the gizzard of a grain-eating bird in its high muscularity.

The heart in reptiles consists of two auricles (right and left) and a ventricle, except in the *Crocodilia,* in which two auricles and two ventricles are developed. Two aortæ or main arterial trunks exist, and are respectively named right and left aortæ. These chief vessels bend round the gullet, and unite to form a single and common main-trunk for the supply of blood to the system generally. But the chief peculiarity in the circulation of all reptiles consists in the peculiar mixture of arterial with venous blood, which takes place in the aorta in such a manner that the head alone is supplied with arterial blood. Although the latter forms possess a four-chambered heart, the circulation is functionally and essentially the same as in other *Reptilia.* It therefore follows that the body in *Reptilia* is nourished by an impure or mixed blood. The reptiles exhibit sluggish habits, slow respiration, and a series of vital actions marked by no active conditions demanding a more perfect circulation or highly-oxygenated blood. The blood is cold (poikilothermic) in reptiles, that is, is but little higher in temperature than the surrounding medium, with changes in which it varies. The red blood-corpuscles are oval and nucleated.

Respiration in reptiles is carried on solely by means of lungs, the presence of branchiæ or gills in early life, and sometimes in the adult life also of batrachians, constituting a marked difference between these latter and reptilian forms. In the *Crocodilia, Chelonia,* and most lizards, the lungs are equally developed, but in serpents and some lizards only one lung is fully developed, the right lung being usually abortive. The lungs may, as in snakes and other *Reptilia,* in which the body is elongated, be of proportionally large size, and may extend nearly throughout the whole length of the body cavity which is not separated by a complete diaphragm into a distinct thorax and abdomen. In the crocodiles, lizards, and serpents the respiratory action is carried on through movements of the walls of the trunks. But in turtles, in which no movements can take place, air is drawn into the lungs by a process analogous to swallowing. The larynx or organ of voice is simple in structure, no vocal cords being in general developed, although these organs appear in crocodiles and some others.

In the higher *Reptilia* the cerebrum attains a comparatively larger size than in the lower forms, while the cerebellum also attains a relatively higher development as we proceed upward. The cerebellum has no lateral lobes nor pons, while the corpora bigemina and thalami are of large size. The senses are developed in tolerable perfection. The nasal cavities are of large size, and open into the mouth through either the anterior or posterior part of the palate. In the *Crocodilia* the hinder nostrils open very far back in the mouth, enabling these animals to hold their prey under water in their mouths, and so to drown it, while their own respiration is carried on unimpeded through the nostrils. The eyes are usually of small size, and exhibit variations in structure and in the disposition of the protective coverings. Thus in snakes the eye-ball in front is covered by a transparent lid, formed by a layer of the skin, which is attached to a circle of surrounding scales, and is shed periodically, with the outer skin. In snakes the pupil of the eye is round. In the lizards movable and ordinary eyelids exist, while the turtles possess a nictitating membrane. In lizards and snakes the sclerotic coat of the eye is strengthened by a circle of bony plates, such as also occur in several extinct reptilian forms and in birds. In the chameleons the single eyelid is formed by the united lids, and through an opening in this circular lid the rays of light enter the pupil of the eye within. The tympanum of the ear is imperfectly developed in *Ophidia,* and no eustachian tube exists. In lizards the tympanic apparatus is better developed, while in chelonians the tympanic cavity is large and complicated, and a rudimentary cochlea exists. The *Crocodilia* possess a movable valve, by means of which the tympanic canal of each ear can be closed at will; and most of the structures found in the ear of higher *Vertebrata* are represented in greater or less structural detail and perfection.

The kidneys are generally placed far back and deep within the pelvic cavity. In the serpents, however, the kidneys are situated anteriorly, and are unsymmetrically placed, the right being placed higher up and in advance of the left kidney, while they are divided into small lobes. No urinary bladder exists, and the urine of the lizards is fluid, that of the serpents resembling the excrement of birds in being pasty and crystalline. In *Crocodilia* the testes are elongated, and placed in front of the kidneys. The penis in *Crocodilia* is single, grooved and contained within a special cloacal fold; in *Ophidia* two lateral penes exist, and these are hollow and evertible; and a double penis exists in lizards, while that of turtles is single.

The eggs are generally of relatively large size, and provided with a thick parchment-like shell and a large yolk. In many instances the eggs may be deposited in sand, and be hatched by the sun's heat.

With regard to the distribution in space of reptiles, the warm or tropical regions of the earth contain these animals not only in greatest number, but in most typical form and variety. During winter, or in the colder seasons of the year, most reptiles hibernate, and many desert species also pass into a summer sleep. Reptiles are varied in their habits, most of them being terrestrial, but many arboreal and some, including the great majority of the turtles, are aquatic. While most are strictly carnivorous or insectivorous, some subsist on a general diet and a few are purely vegetarian. Many of the extinct forms fed exclusively on fishes. Reptiles exhibit many interesting habits, but, owing to a popular prejudice against them, and the tax on the patience of the observer resulting from their inactivity and secretiveness, they have been comparatively little studied.

Because of certain resemblances in form and manners, all of the early zoologists, to and including Cuvier, classed the *Reptilia* and *Amphibia* together, and it was only when embryological data began to play an important part in taxonomy that their dissimilarity was perceived. Milne-Edwards and his contemporaries toward the middle of the 19th century were the first to recognize this in a scheme of classification. In 1860-70 when zoologists were still working under the fresh stimulus of the publication of the 'Origin of Species,' Huxley, Haeckel, and Cope almost simultaneously perceived much more clearly than had any of their predecessors the close relationship and probable community of descent of birds and reptiles. Reptilian life played a so much more important role in past ages of the earth than now, that it is not surprising that we must turn to palæontologists for nearly all of the recent advances in the classification of the groups. The scheme and nomenclature mainly followed in this work is that elaborated by Gadow in Vol. VIII. of the 'Cambridge Natural History.'

CLASS REPTILIA.

Subclass *Proreptilia.*

Subclass *Prosauria.* Orders: Microsauri, Prosauri (Rhyncocephalia, etc.).

Subclass *Theromorpha.* Orders: Pareiasauri, Theriodontia, Placodontia, Anomodontia.

Subclass *Chelonia* (Turtles). Orders: Atheca, Thecophora.

Subclass *Dinosauria* (Dinosaurs). Orders: Sauropoda, Theropoda, Orthopoda, Ceratopsia.

Subclass *Crocodilia* (Crocodilians). Orders: Pseudosuchia, Parasuchia, Eusuchia.

Subclass *Plesiosauria.* Orders: Nothosauri, Plesiosauri.

Subclass *Ichthyosauria.* Orders: Ichthyosauri (Fish-lizards).

Subclass *Pterosauria* (Flying Reptiles). Order: Pterosauri (Pterodactyls).

Subclass *Pythonomorpha.* Orders: Dolichosauri, Mosasauri.

Subclass *Sauria.* Orders: Lacertilia (Lizards); Ophidia (Serpents).

A more elaborate scheme, but one which more correctly expresses the natural relationships of the orders, has been developed by Cope, Baur, and Osborn.

The vast majority of reptilian types have become extinct. Only four orders are represented in our modern fauna, and one of these, the *Rhynchocephalia,* by only a single species, the New Zealand tuatera (q.v.). The *Crocodilia* have greatly declined in variety of forms since the close of the Mesozoic Age. The *Pythonomorpha* have become extinct, but lizards and snakes are represented in the saurian orders by a great number of species, and are the only dominant reptilian types. Reptiles flourished especially during the Mesozoic Age, to which four of the most remarkable groups were confined, the great marine reptiles (*Plesiosauria* and *Ichthyosauria*), the huge and often remarkably modified terrestrial *Dinosauria,* and the equally wonderful flying *Pterosauria.* This epoch, when the seas were shrinking and dry land increasing in extent, but when the atmosphere was heavy with moisture and carbonic-acid gas, unfitted for the respiration of high types of life, was well suited for the development of the sluggish reptiles; and they were dominant on land and sea, replacing on the one hand the amphibians and on the other the primitive types of fishes of earlier ages. With the close of the Age of Reptiles and the advent of the Eocene Period, mammals quickly rose to full dominance on the land, and many orders of reptiles, having played their parts in the evolution of life, disappeared forever. Reptiles sprang from the stegocephalian *Amphibia.* From some group of the *Theromorpha* (of the synapsidan series) mammals are supposed to have come; while birds took their origin from the diapsidan line, probably in common with some primitive dinosaurian.

Consult, besides the numerous articles in this work on special orders and kinds of reptiles, the following: Cope, 'The Crocodilians, Lizards, and Snakes of North America,' Rep. U. S. Nat. Mus. (Washington, 1900); Holbrook, 'North American Herpetology' (Philadelphia, 1842); Gadow, 'Amphibia and Reptiles' (New York, 1901); Boulenger, 'Catalogue of the Reptiles in the British Museum' (London, 1889-96); Osborn, 'The Reptilian Subclasses Diapsida and Synapsida,' Memoirs Amer. Mus. Nat. Hist. (New York, 1903); Woodward, 'Vertebrate Palæontology' (Cambridge, 1898).

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Rep'ton, a village of Derbyshire, England, about seven miles from Derby; it was once an episcopal see and capital of the kingdom of Mercia, and had a celebrated nunnery from 660 till its destruction by the Northmen in 874. From 1172 till the dissolution of the monasteries under Henry VIII. it was the seat of a priory of Austin friars; part of the priory buildings is incorporated in the fabric of the Repton free grammar school, founded in 1556, one of the great English public schools. The parish church is notable for its curious crypt, consisting of a centre and side aisles divided by three arches on either side.

Republic, a word signifying a state in which the people are the source of power. The degree of popular sovereignty in republics has varied very widely in the past, most of the so-called republics having been ruled by an aristocracy which jealously guarded its own rights, but treated the multitude as little better than slaves. Real republican government may be said to date from the American Declaration of Independence, and even in the United States the government was largely one of class until about the second quarter of the 19th century, when suffrage barriers began to break down. The other so-called American republics are mostly military despotisms, in which order or disorder is maintained by force under the command of a successful general. Argentina is an exception to this rule, and Chile and Brazil are also gradually becoming inspired by the real republican spirit, while Cuba, the youngest of American republics except Panama, which has just been admitted to the family of nations, is making an excellent record. In Mexico the strong hand of Porfirio Diaz has lifted that rich republic from a chaotic, almost barbarous condition to a reign of law and order, progress and prosperity.

As an instance of the way in which the term «republic» was used or abused in the past, it may be mentioned that Poland was formerly called a republic because the king was elected by the nobles; and in the 18th century it was not uncommon to designate the German empire by the appellation of the «republic of princes.» The large commercial cities of Italy, Genoa, and Venice were called republics because they were governed by an aristocracy of noble families, who appointed one of their number to be supreme chief of the state, as the *doge*. The republican institutions of the greater part of the Greek states, as well as that of Rome, at least in later times, were of a more democratic character. The first republic of any great extent in modern Europe was the confederation of the seven provinces constituting the Dutch Republic, after their separation from Spain, and which continued until the year 1815, when it became a hereditary monarchy. Switzerland became a republic after having freed itself from German rule. Great Britain was nominally a republic for 11 years, from 1649 to 1660, as also was France from 1793 to 1804. France again assumed a republican constitution in 1848, which, however, only lasted till 1852. But on the 4th of September 1870 a republic was established in France for the third time in its history, and it is likely to continue to exist. The republics created in Hungary, Italy, Baden, and Rhenish Bavaria after the revolutionary movements of 1848 were all very ephemeral. Spain possessed a republican government twice in the course of somewhat recent years — in 1868–9 and in 1873–4. Besides the quasi-republican cities of Germany — Bremen, Hamburg, and Lübeck — and the diminutive republics of San Marino, in Italy, and Andorra, the only republics in Europe at the present day are those of Switzerland and France. In the New World, on the other hand, the republican form of government prevails universally among the independent states, the most important of all the republics there being, of course, the United States.

Of the tiny republics of the world San Marino is the best known. It is situated in central Italy, and its territory covers about 33 square miles and the population numbers about 8,500 souls. This miniature state was founded in the 4th century by Saint Marinus, who, having embraced Christianity, fled there to escape the persecution under Diocletian. The capital, San Marino, is on the crest of a mountain over 2,000 feet high and has a population of 1,200. It is one of the most picturesque places in the world, being perched on perpendicular cliffs.

The small half French and half Spanish republic of Andorra, which lies in an almost inaccessible valley of the eastern Pyrenees, possesses a charter of rights dating from Charlemagne in 790. There is but one way of getting to Andorra from France and that is by the river Bolira. To reach it from Spain one has to be carried down by mule over one of the most dangerous footpaths in Europe. There are six parishes in the republic, and the whole contains about 6,000 people, the territory covering an area of 148 square miles.

Repub'lican, the river which unites with Smoky Hill River, at Junction City, Kan., to form the Kansas River. The Republican is formed by two streams which unite in east central Colorado. The river flows northeast into Nebraska, then east and southwest, entering Kansas at Superior in Jewell County, continuing south, east, and southeast to the Kansas River.

Republican Party, The. The Republican Party was an inevitable outgrowth of the conditions which prevailed about the time of the repeal of the Missouri Compromise in 1854. The Whigs, incapable of grappling with new problems, were rapidly disintegrating; no one of the sporadic parties sprouting in the political confusion of the time was based on broad enough principles to become a truly national organization; the Republican Party, germinating in the Free Soil movement and inheriting Whig and Federalist traditions, happily combined the inspiration of a great moral principle, with the enduring quality of sane policies in Federal administration. Its origin cannot properly be ascribed to any particular date or place. The first known suggestion of the name was in a letter written by Horace Greeley. The earliest convention of importance to adopt it was held at Jackson, Mich., 6 July 1854. Virtually coincident with the Michigan convention there were conventions in Maine, Illinois, Massachusetts, Ohio, Indiana, Wisconsin, and Iowa; almost spontaneously the Republican Party had become a strong national organization. On the roster of the 33d Congress, the name «Republican» does not appear; in the 34th Congress, which met 3 Dec. 1855, there were in the Senate 15 Republicans, 42 Democrats and 5 Americans; in the House of Representatives there were 108 Republicans, 83 Democrats, and 45 Americans. The Whigs had disappeared. Nathaniel P. Banks, of Massachusetts, was chosen Speaker of the House by a combination of Republicans and Americans, after a memorable contest.

Steps were taken at once to put a ticket in the field for the approaching election of President. The chairmen of the state committees of Maine, Vermont, Massachusetts, New York, Pennsylvania, Ohio, Michigan, Indiana, and Wisconsin called an informal convention to meet at Pittsburg 22 Feb. 1856. A committee appointed at that meeting called a national convention to meet at Philadelphia 17 June 1856 to nominate candidates for President and Vice-President. The call was addressed to "the people of the United States, without regard to past political differences or divisions, who are opposed to the repeal of the Missouri Compromise, to the policy of the present administration, to the extension of slavery into the territories, in favor of the admission of Kansas as a free State, and of restoring the action of the Federal government to the principles of Washington and Jefferson". John C. Frémont, of California, was nominated for President, and William L. Dayton, of New Jersey, for Vice-President, on a platform, the most conspicuous plank of which read as follows:—

> Resolved, That the Constitution confers upon Congress sovereign power over the territories of the United States for their government and that in the exercise of this power it is both the right and the imperative duty of Congress to prohibit in the territories those twin relics of barbarism, polygamy, and slavery.

It was essentially a one-idea convention, although resolutions were adopted favoring national aid for a railway to the Pacific coast, and liberal appropriations for rivers and harbors; but the party was not long to remain thus limited in its mission. The convention of 1860, which nominated Abraham Lincoln for President, adopted resolutions which committed the new party to the doctrine of a protective tariff, in the following clause:—

> That, while providing revenue for the support of the general government by duties upon imports, sound policy requires such an adjustment of these imposts as to encourage the development of the industrial interests of the whole country; and we commend that policy of national exchanges which secures to the workingmen liberal wages, to agriculture remunerative prices, to mechanics and manufacturers an adequate reward for their skill, labor, and enterprise, and to the Nation commercial prosperity and independence.

The Republican Party is thus seen almost from the beginning to have been committed to the protective policy which remains to-day one of its great principles. The election of 1856 resulted in a Democratic victory. James Buchanan received 174 electoral votes; Frémont received 114. It is perhaps fortunate that the new party did not then meet with success. Their candidate was a popular hero. No better name could have been selected about which to rally a new party devoted to a moral idea. Had the party been successful in 1856, however, the War of the Rebellion would doubtless have begun then, and Frémont by temperament and experience was ill-fitted to grapple with such a problem. The inspiration of the campaign which he led carried the Republican Party up to the momentous success of 1860. When the clouds broke, Abraham Lincoln was at the head of the state endowed beyond all other men of his time with the ability to cope with such a storm. The National Convention at Chicago, 16–18 May 1860, nominated Abraham Lincoln, of Illinois, for President, and Hannibal Hamlin, of Maine, for Vice-President. In the election which followed Lincoln and Hamlin received 180 electoral votes; all others received 123 electoral votes. In April immediately following Lincoln's inauguration, Fort Sumter was fired upon and the Civil War began. The war occupied the four years of Lincoln's administration. The Republican Party was not only charged with the heavy work of administration, but it was responsible for the preservation of the government. When it entered upon the war, the government was without military preparation. Congress and the President were compelled to build navies, raise armies, to provide money, and to fight the battles of the Republic. In the midst of the war, on 1 Jan. 1863, the proclamation of emancipation went into effect. An election for President was held near the end of the war, in November 1864. The Democratic Party nominated General George B. McClellan, of New Jersey, for President, and George H. Pendleton, of Ohio, for Vice-President. The principal plank of its platform was a blunt declaration that the war was a failure. The Republicans at Baltimore, 7 June 1864, renominated Lincoln for President, with Andrew Johnson, of Tennessee, for Vice-President. During the early days of the campaign, even Lincoln believed the Republican ticket would be defeated at the polls, and he began preparations for a Democratic successor; but Lincoln received the electoral vote of every State not in the rebellion except Kentucky, Delaware and New Jersey — 212 electoral votes; McClellan received 21.

The assassination of Lincoln, 14 April 1865, was a calamity not only to the country but also to the Republican Party, upon which was pressing at the moment the problem of reconstruction growing out of the Civil War. Lincoln had the qualities needed at that time — firmness, moderation, and political sagacity. Andrew Johnson, who succeeded to the Presidency, was ill-fitted either by temperament or by training to deal with the delicate questions which then arose. He was hot-headed, uninformed, and unbalanced in judgment. He was soon at odds with the leaders of his party in Congress, and by his obstinacy drove them to extremes which might have been avoided had the Executive been guided by a broader intelligence. All the measures of reconstruction were forced through in spite of the President's opposition. The differences became so marked that in February, 1868, articles of impeachment were brought against the President by the House of Representatives. In the impeachment proceedings in the Senate the President was not convicted. The vote was: Guilty, 35; not guilty, 19,— one less than the two thirds majority required by the Constitution for conviction.

Ulysses S. Grant, of Illinois, was the unanimous choice of the Republican National Convention, which met at Chicago 20–21 May 1868. Schuyler Colfax, of Indiana, was the candidate for Vice-President. In the election which followed, Grant and Colfax received 214 electoral votes. Seymour and Blair, the Democratic candidates, received 80. Throughout Grant's first administration, both Senate and House were strongly Republican. The 15th amendment to the Constitution having been recommended by Congress and adopted by the States, was proclaimed on 30 March 1870. To Grant fell the task of bringing the Southern States, lately in rebellion, into adjustment with the reconstructed Union. The problems of his first administration were largely those which grew out of this new relationship. The former slaves in Southern States exercised for the first time their newly acquired privilege of voting. The state governments of negroes and carpet-baggers which were set up became a scandal. The outrages committed by Southern Democrats upon all Republicans of whatever color aroused the resentment of the North, and kept the South in a condition of disorder which necessitated constant Federal interference.

The situation in the South, coupled with differences between the administration and certain Republican leaders, conspicuous among whom were Charles Sumner and Horace Greeley, caused a defection in the Republican ranks. The discontented Republicans met at Cincinnati in May, 1872, and nominated Horace Greeley, of New York, for President, and B. Gratz Brown, of Missouri, for Vice-President. The platform declared that sectional issues should be buried, that civil service reform should be inaugurated and that specie payment should be immediately resumed. The Democratic convention at Baltimore in July accepted the Liberal Republican candidates and platform. The regular Republican convention at Philadelphia, 5–6 June, renominated Gen. Grant for President by acclamation, and put Henry Wilson, of Massachusetts, on the ticket with him. Grant and Wilson received 286 electoral votes out of 366.

The first two years of Grant's second administration witnessed a strong reaction against the Republican party. There was a financial panic in 1872 and 1873, and the scandals of the whiskey ring in the Treasury Department, and of the post traderships in the War Department, involving men who were regarded as close to the administration, created a strong feeling throughout the country. The general dissatisfaction resulted in a political overturn in 1874. For the first time since 1860 the House of Representatives in the 44th Congress contained a Democratic majority.

By the time the Presidential election of 1876 arrived the Republican Party had regained much of the ground it had lost. Rutherford B. Hayes, of Ohio, was nominated for President in the convention at Cincinnati 14–16 June 1876. William A. Wheeler, of New York, was nominated for Vice-President. The Democratic candidates, nominated at Saint Louis, were Samuel J. Tilden, of New York, and Thomas A. Hendricks, of Indiana. The Democrats went into the campaign with a cry of «Turn the rascals out.» In the election which followed Tilden and Hendricks received a majority of the popular vote. There was a dispute in regard to the electoral votes of South Carolina, Florida, Louisiana, and Oregon. The disputed votes were finally referred to an Electoral Commission, composed of five Senators, five Representatives, and five Justices of the Supreme Court. After a long hearing, during which the country was in great excitement, the Commission awarded all the contested votes to Hayes and Wheeler, and they were declared elected, receiving 185 electoral votes. Tilden and Hendricks received 184 votes. The administration of President Hayes is notable for two reasons. He withdrew Federal troops from the South, thus leaving the negro voters at the mercy of the white population. The Southern States, which had been Republican up to 1876, now passed under Democratic control, and have remained Democratic with only occasional exceptions, ever since. Under the administration of John Sherman, as Secretary of the Treasury, specie payments were resumed and the finances of the government were fixed firmly on a substantial foundation. President Hayes had to deal with a Democratic House of Representatives throughout his term.

In the election of 1880, James A. Garfield, of Ohio, and Chester A. Arthur, of New York, nominated at Chicago 2–8 June, were chosen President and Vice-President respectively, receiving 214 votes against 155 electoral votes cast for Hancock and English. They also received a plurality of the popular vote. For the first time since 1874 the Republicans controlled the House of Representatives. The Senate was evenly divided. President Garfield was shot on 2 July 1881, and died on 19 September, leaving the administration in the hands of President Arthur. During Arthur's administration the Civil Service Commission, was created and the first steps were taken to divorce the great body of subordinate offices in the civil service from the changes incident to party politics. Under the administration of William E. Chandler, as Secretary of the Navy, the building of the new navy was begun. A treaty was negotiated with the government of Nicaragua, looking to the construction of an inter-oceanic canal. This treaty had not been ratified by the Senate when the administration came to an end, and President Cleveland promptly withdrew it upon entering the White House. The administrations of Garfield and Arthur were marked by factional differences in the Republican Party. The elections for Congress in 1882 resulted adversely, and in the 48th Congress there was a Democratic majority of 73. Grover Cleveland was elected Governor of New York by a majority of nearly 200,000 over Secretary Folger, who had been nominated for Governor through administration influence. In the election of 1884, Blaine and Logan, the Republican candidates for President and Vice-President — nominated at Chicago 3–6 June — were defeated by Cleveland and Hendricks, the Democratic candidates, receiving 182 electoral votes as compared with 219 for their opponents. The campaign was fought almost solely on the personality of Mr. Blaine, and has never been excelled for bitterness. The result was determined by a plurality of 1,149 in a total vote of 1,200,000 in the State of New York. The Democrats controlled the House throughout the Cleveland administration, but the Republicans had a majority in the Senate, which prevented affirmative legislation of any consequence. President Cleveland brought the tariff question sharply to the front in his message of 1887, and the agitation which grew out of that message resulted in a campaign fought on the tariff issue in 1888. The Republicans in that year, in a convention at Chicago, 19–25 June, nominated Benjamin Harrison, of Indiana, for President, and Levi P. Morton, of New York, for Vice-President. The Democrats renominated President Cleveland, and placed Allen G. Thurman, of Ohio, second on the ticket. Harrison and Morton received 233 electoral votes; Cleveland and Thurman received 168. Both Senate and House were strongly Republican. The administration of President Harrison was signalized by the enactment of important legislation, and by a strong foreign policy. Thomas B. Reed was Speaker of the House of Representatives in the 51st Congress, with a narrow Republican majority. The Democratic minority essayed at the beginning of the Congress to prevent all Republican legislation by appealing to the technicalities of antiquated rules. Speaker Reed in the face of vehement opposition secured the adoption of new rules, under which it became possible for the majority to do business. The Reed rules, although angrily assailed by the Democratic minority, were adopted by the Democratic Party when it next came into control of the House, and they have prevailed ever since. Having obtained the power to legislate, the Republican Party in the House proceeded to enact a tariff bill in obedience to the command of the electorate. The McKinley act was signed 1 Oct. 1890. A law was passed, known as the Sherman anti-trust law, providing penalties for creating combinations in restraint of interstate trade. The House of Representatives passed a bill looking to the more efficient control of Federal elections. This measure aroused great Democratic opposition. It failed to pass the Senate. During Harrison's administration a revolution in Hawaii resulted in the deposition of Liliuokalani, the native queen. A republic was set up, and a commission was sent to Washington seeking annexation to the United States. President Harrison made a treaty of annexation which the Senate failed to ratify in the few weeks remaining of the administration. The treaty was withdrawn by President Cleveland, but Hawaii was finally annexed shortly after the return of the Republican Party to power in 1897.

The congressional election of 1890 was fought on the issue created by the McKinley bill. That act went into operation only a month before election, and there was no opportunity to observe its practical workings. Its intent and effect were misrepresented, and the Democrats carried the House of Representatives by an unprecedented majority. In the 52d Congress, the House contained 235 Democrats and only 88 Republicans. The election of 1892 resulted in turning all branches of the government over to the Democratic Party. Cleveland and Stevenson were elected President and Vice-President, receiving 277 electoral votes; Harrison and Reid, nominated at Minneapolis, 7–10 June 1892, received 145 votes. Both House and Senate were strongly Democratic in the 53d Congress. The administration had come in on a platform which denounced protection as a fraud, and declared it to be a fundamental principle of the Democratic Party that the Federal government has no constitutional power to impose and collect tariff duties except for the purposes of revenue only. The election of a Democratic President on this platform created distrust in business circles and caused a paralysis of industry which resulted in a financial panic, hitherto unequaled, during the spring of 1893. President Cleveland, assuming that the financial depression was due to the operation of the Sherman act, providing for the purchase of silver bullion, called a special session of Congress to repeal that act. The Republicans in the House and Senate combined with a small number of Democrats to carry out the President's recommendation, and finally after weeks of heated discussion the law was repealed, but the financial situation was not relieved. The money stringency continued with the dread of tariff legislation hanging over the country. A tariff bill was enacted after months of debate which did not go to the lengths recommended by the President, and which he accordingly denounced as an act of perfidy and dishonor, although he refrained from vetoing it. The fight over the repeal of the Sherman act and over the Wilson-Gorman tariff act disrupted the Democratic party. The unpopularity of the administration's foreign policy completed the disintegration, and at the congressional elections held in 1894, the Republican Party again came into control of both branches of Congress.

In 1896 the Republicans at Saint Louis, 16–18 June, nominated William McKinley for President, and Garret A. Hobart, of New Jersey, for Vice-President, on a platform declaring for a protective tariff and for the maintenance of the gold standard. The Democratic convention at Chicago was carried away by the cry for free silver coinage at the ratio of 16 to 1. William J. Bryan, of Nebraska, and Arthur S. Sewell, of Maine, were nominated for President and Vice-President, respectively. The campaign was fought chiefly on the financial planks of the two platforms. McKinley and Hobart were elected by a decisive majority, both in the electoral college and of the popular vote. They received 271 electoral votes. Bryan and Sewell received 176 votes. Both Senate and House were strongly Republican, in the 55th Congress. Thomas B. Reed was Speaker of the House, and Nelson Dingley, of Maine, was chairman of the Committee on Ways and Means. A special session of Congress was called to carry into effect the pledges of the party with regard to the tariff. The Dingley tariff act became law 24 July 1897. It marked the beginning of a period of prosperity unequaled in the previous history of the United States.

The disturbed conditions in Cuba growing out of the uprising against Spanish misgovernment were rapidly reaching a point where intervention by the United States would have become inevitable when the destruction of the battleship Maine by a Spanish mine in Havana harbor on 15 Feb. 1898 roused the resentment of the people and precipitated the war with Spain. The war began on 21 April 1898. The American forces gained two great victories by sea, one in Manila Bay, on 1 May 1898; the other off Santiago harbor on 3 July. After a brief and effective campaign by land, Spain sued for peace. The treaty of peace was signed at Paris on 10 Dec. 1898. It provided for the acquisition by the United States of the island of Porto Rico in the West Indies and of the Philippine Archipelago and the island of Guam in the Pacific. It placed the island of Cuba temporarily under the guardianship of the United States. The McKinley administration undertook the government of the newly acquired territory with all the serious problems involved. It quickly set up a stable American government in Porto Rico. It brought order in Cuba under a military administration, prepared the people of the island for self-government, and on 20 May 1901 withdrew the American military forces, permitting the Cuban people to set up an independent republic of their own. In the Philippines, after four years of armed opposition by guerrilla tribes in Luzon, a civil government was finally established and the people of the island were given a degree of civil freedom such as they had not known in 400 years. Early in the McKinley administration resolutions were enacted providing for the annexation of Hawaii on terms similar to those contemplated by President Harrison in the treaty of annexation, which President Cleveland withdrew. President McKinley was renominated at Philadelphia on 19-21 June 1900. Theodore Roosevelt was nominated by acclamation for Vice-President. William J. Bryan was again nominated for President at Kansas City on 4 July, with Adlai E. Stevenson, of Illinois, for Vice-President. The Democrats re-affirmed the platform of 1896 with its declaration of free-silver. But they declared the paramount issue to be the question of imperialism. The Republican candidates received 292 votes in the electoral college; the Democratic candidates 155 votes. The Republicans retained control of both Senate and House. On 6 Sept. 1901, President McKinley was shot at Buffalo by the anarchist Czolgosz. On 14 September he died. Vice-President Roosevelt succeeded to the Presidency. He pledged himself to carry out the McKinley policies under which the country had experienced unparalleled prosperity and he retained all members of President McKinley's cabinet. During President Roosevelt's administration all laws were strictly enforced. The army was reorganized and a strong foreign policy maintained so successfully that, in 1904, the popular demand for his re-nomination was imperative. He was elected, therefore, by a vote of 336 to 140 cast for Judge Parker. Charles W. Fairbanks, of Indiana, was the candidate for the vice-presidency.

The preamble of the platform of the Republican Party, which was adopted at Chicago 22 June 1904, contained the following review of the purposes for which the party had stood for half a century. It had been dedicated, it stated, among other purposes in the past, to «arresting the extension of human slavery,» and using this as a text, the platform developed in detail the proposals for the coming administration for which Mr. Roosevelt had been nominated as President. It stated that, «after four years of Democratic rule, in evil plight, oppressed with misfortune, and doubtful of the future, public credit had been lowered, the revenues were declining, the debt was growing, the Administration's attitude towards Spain was feeble and mortifying, the standard of values was threatened and uncertain, labor was unemployed, business was sunk in the depression which had succeeded the panic of 1893, hope was faint, and confidence was gone.» Then was pointed out the proud allegation that the Republican Party had «replaced a Democratic tariff law, based on free-trade principles and garnished with sectional protection, by a consistent protective tariff; and industry, free from suppression and stimulated by the encouragement of wise laws,» had expanded to a degree never before known, had conquered new markets and had created a volume of exports which surpassed imagination; that under the Dingley Tariff labor had been fully employed, wages had risen and all industries had revived and prospered.

The first declaration of principles for the future which the platform contained was in favor of the gold standard, and explaining why the party favored this principle. The settlement of affairs in Cuba, Porto Rico, the Philippines, and all the relations of American industrial life had depended upon the gold standard. Our possession of the Philippines was defended in a strong paragraph. The Panama Canal undertaking would be carried on as it had been begun by strong Republican endorsement and lines of effort. Likewise, anti-trust laws, enacted by the Republican Party, «which the Democratic Party failed to enforce,» would be carried forward, and new laws would be enacted insuring «reasonable publicity as to the operations of great corporations and providing additional remedies for the prevention of discrimination in freight rates.» The protective tariff was restated and upheld. The further extension of commercial reciprocity, already secured by the Republican Party, would be effected, «without injury to American agriculture, American labor, or any American industry.» The merchant marine would be upbuilt by the furtherance of the work of the Merchant Marine Commission. A strong navy would be built up. Chinese labor would be excluded. Civil service laws would be enforced. International arbitration would be favored, as it had been by the administrations of President McKinley and President Roosevelt. Congressional action would be taken to determine «whether by special discriminations the elective franchise in any State has been unconstitutionally limited» (this referring to negro disenfranchisement), the demand being that «representation in Congress and in the Electoral College shall be proportionately reduced as directed by the Constitution of the United States.» Combinations of capital and labor should not be permitted to «infringe upon the rights and interests of the people,» although «when lawfully formed for lawful purpose,» such combinations are «alike entitled to the protection of the laws, but both are subject to the laws, and neither can be permitted to break them.»

The Republican platform adopted at Chicago 18 June 1908, upon which Secretary of War, William Howard Taft, was elected over Mr. Bryan (Dem.) and others, was longer, though no stronger, than that of 1904.

Republicanism under Mr. Roosevelt was reviewed. Equality of opportunity was pointed out as a leading principle and attainment of American life under Republican rule. The attainments of the nation in both its internal and external affairs were described. The revival of business and the wise and progressive legislation recently adopted were pointed out. The party declared unequivocally for a revision of the tariff by special session of Congress immediately following the inauguration of the next president, for which purpose a thorough investigation of schedules and trade conditions was recommended. The currency laws were justified. The establishment of a postal savings bank system was favored. «Greater supervision and control over the trusts» was urged by «greater publicity in the management of that class of corporations engaged in interstate commerce having power and opportunity to effect monopolies.» The party gave its approval to «the enactment of the Railroad Rate Law and the vigorous enforcement by the present administration of the statutes against rebates and discriminations»; especially favoring such national legislation and supervision as would «prevent the future overissue of stocks and bonds by interstate carriers.» Laws for the protection of railroad and government employes were recommended; likewise the policy of protection of

American labor in general. The authority and integrity of the courts and court procedure were upheld. The welfare of the American farmers was duly considered. Justice to the negro was sought by clearly defined recommendations. The improvement of natural resources and waterways; the strength and efficiency of the army and navy; the protection of American citizens abroad; the extension of foreign commerce; arbitration and the Hague treaties; the revival of the merchant marine; the increase in the pension list; maintenance of the civil service; the public health; the establishment of a bureau of mines and mining; citizenship in Porto Rico; home rule in the Philippines; the completion of the Panama Canal; the admission of the Territories of New Mexico and Arizona as separate States—all were given strong recommendations in this platform.

See also DEMOCRATIC PARTY, where the result of the election itself is analyzed. The proper course of legislation in 1909-10 was unusually plain, on account of the Chicago platform of 1908, in the drawing of which Mr. Taft himself had had a prominent part. As President he at once upheld the fact that this platform was part of a tacit contract with the people, and that its pledges were to be fulfilled. Therefore, in both his speeches and messages, he called the attention of the legislators repeatedly to its provisions.

Since the Republican Party came into power for the first time in 1861 it has been continuously in possession of the Presidency except during the periods between 1884 and 1888 and between 1892 and 1896. It has been in control of the House of Representatives except during the 44th, 45th, 46th, 48th, 49th, 50th, 52d, and 53d Congresses. It has been in control of the Senate almost continuously, the only lapse being between 1879 and 1881 and between 1893 and 1895. It has thus in effect had control of the government for 45 years and there is not a single important piece of legislation on the statute books to-day which was not placed there by the Republican Party. The only important legislation enacted by the Democratic Party in 45 years has been the Wilson-Gorman tariff act which a Democratic President allowed to become a law without his signature and which was repealed by the Congress immediately succeeding that in which it was enacted. The Republican Party has brought two wars to a successful conclusion,— the Civil War and the war with Spain. It has abolished slavery in the United States. It has placed on the statute books four protective tariff acts, the Morrill tariff of 1861, the tariff of 1883, the McKinley tariff of 1890, and the Dingley tariff of 1897. It enacted in 1862 the Homestead Law, under which the vast unoccupied territory of the West was thrown open to settlement by American citizens. It is responsible for the 13th, 14th and 15th amendments to the Constitution and for the acts of reconstruction immediately following the Civil War. It is responsible for the resumption of specie payments in 1878, and for the creation of the Civil Service Commission divorcing the subordinate offices in the government service from party politics. It is responsible for the reform of the rules of the House of Representatives under Speaker Reed enabling the majority to transact business. It is responsible for the upbuilding of the American navy until it ranks third in size among the navies of the world, and second to none in efficiency. It has reorganized the army and put it in a state of constant readiness. It has added to the national domain Alaska, Porto Rico, Guam, Hawaii, and the Philippines. It has set up an independent republic in Cuba. Since it came into power the country has increased in population from 31,443,321 in 1860 to nearly 100,000,000 in 1912. The wealth has increased from $16,159,616,000 in 1860 to $130,000,000,000 in 1912.

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Republics, The History of. The word Republic is derived from the Latin *res*, a thing, and *publicus*, belonging to the people. The word is frequently applied to any group of individuals having a common interest in their pursuits, as the republic of letters. Its general usage, however, is as a political designation for a state or country in which the supreme power of governing is vested in rulers elected periodically by those of its citizens who have acquired the right to vote. In the narrowest sense, a republic is a democracy where political power rests in all the people and is wholly in their unrestricted control. It is the antithesis of a monarchy, where the power rests in one individual or family and is self-perpetuating through dynastic succession. Between these two extremes of monarchic and democratic government are other forms, of oligarchic or aristocratic character, where the right of participation in the direction of public affairs is in the hands of classes or of a restricted portion of the community. Strictly speaking, these are not republics, but in history nearly all authorities agree in so regarding and placing them. Republics may be divided into two distinct types, the centralized and the non-centralized. A centralized republic is one in which all power is deputed to and is exercised by the general government entirely independent of local authority in any of the sub-divisions of the country. France and some of the South American republics are examples of the centralized republic. When the power of the general government is derived, to a greater or less extent, from the local constituent bodies or states which also have independent rights and powers over which the general government has no constitutional control, we have the non-centralized republic. The Greek republics, the free cities of Germany and the United States of America are examples of the non-centralized republic.

The Earliest Republics.— In pre-historic times when men first began to feel the necessity for communal control of their affairs and inter-relations, government took somewhat the form that has persisted in modern times in the monarchy. At the beginning this was patriarchal, as history shows us at later date among the Hebrews, the Pelasgians, and other early races. The head of the family was recognized as supreme in authority, first over his immediate family and then over its branches. As the associated families grew in number and size, and expanded into tribes, the strongest family or group of families asserted its pre-eminence, by force or peacefully, by common consent, and became the ruling power; hence the king and the dynasty. It was a reversion from this condition that led to the earliest republics of which history has anything to tell. Among the Israelites, the patriarchical or family government continued until the time of the Egyptian serfdom. When, under Moses, the people escaped from Egypt and became again free and independent, the Israelitish Commonwealth or Republic was established; it lasted nearly four centuries, from 1491 B. C. to 1095 B. C. Under Moses and Joshua the government was of the consolidated and centralized type. All the people, young and old, rich and poor, male and female, had a voice in public affairs and the privilege of political preferment. Here we have the earliest record of choosing rulers by elective franchise. Only the priesthood was a privileged class. Laws were beneficent and wise. A general system of education was established. The military spirit was fostered so that the nation became a strong power. Usury was illegal and interest was regarded with disfavor. An agrarian law assigned to each family a small acreage of land and this was made inalienable; it could not be held under mortgage or sale. Of this early stage of the republic it has been said that "the descendants of Abraham had reached a higher state of virtue and happiness than any other nation of that period." Upon the death of Joshua the seeds of disintegration were sown. The different states seceded, forming independent confederacies, although generally all were united for common defense. Dissensions arose, patriotism weakened, officials became dishonest and finally the people, whose will was still the highest law of the land, demanded of Samuel a king. Saul was anointed king in 1095 B. C. and that was the end of the Israelitish republic.

Greece.—In the Heroic Age, Greece was divided into several states or tribes, each ruled by a chief or king. It was about the time of the first Olympiad — 776 B. C.–772 B. C., that the people began to aspire to political independence, and they gradually deposed the kings, setting up chosen rulers in place thereof. At first the new governments were oligarchal, but in the course of time, all of them, except that of Sparta, became democratic. The states were only loosely bound to each other and national unity was altogether lacking. Athens became foremost in the time of Thucydides and exercised a sort of sovereignty over the entire country. But after a while Sparta imposed her oligarchic system upon the other states and then again Thebes had the ascendancy. Greek civilization, Greek laws, Greek art, Greek literature, Greek patriotism, became forces that have never ceased to dominate the world. But the passion for wealth and display, local political strife and particularly jealousy between the different states and cities led to dissension and disunion. Greece came under the influence of the Persian monarchs, then was ruled by the Macedonian kings, Philip and Alexander, and finally, when in 146 B. C., the Roman legions conquered Macedonia, the last Grecian league, the Achæan, and then Athens, were completely vanquished. Successively under the domination of the Roman Empire of the East, the Byzantine Empire and Turkey, Greece, finally reunited, became an independent kingdom, under a constitutional monarchy in 1832.

Carthage.—Carthage had its beginnings before history had its records. Five centuries before Christ, it flourished under rulers who were not hereditary, but who were elected by the people. The Commonwealth of Carthage was a centralized republic, unlike that of Greece and similar to that of Rome. In the Great Council of the State and in the Council of the Elders there was something of aristocracy, but on the whole the people were in control. There was a liberal administration in the interest of all citizens alike, courts of justice, banking institutions, public libraries and schools of literature and art. Carthage acquired great wealth and a high degree of civilization. Her territory was wide, extended and rich, and the city, Carthage, capital of the country, was the most superb of that day, being to the republic what Paris is to France. Carthaginians conquered the then known world, penetrated to the interior of Africa and sailed around the Cape of Good Hope, and through the British Channel. The prosperity of the Commonwealth begat its downfall. Political feuds developed and its citizens became divided into factions. Rome, grown in power, saw the opportunity for revenge for earlier defeats and humiliations. Her legions swept over the country. Carthage, the splendid city, was blotted from the face of the earth, never to reappear, and with her went every vestige of the republic of which she was the metropolis.

Rome.— Like Israel and Greece Rome had its political beginning in peoples who were organized in families, clans and tribes. In the early Roman state a king was the ruler, partly an hereditary chief and partly an elected magistrate. Naturally the kingly office grew in importance and power until in the time of the Tarquins it was well-nigh supreme. Still even during this regal period the people retained much power. The inhabitants were divided into two classes, patricians and clients, and the franchise and right of office-holding were possessed only by the former. A similar condition existed under the Etruscan kings, who ruled from the 7th century before Christ. With the deposition of Tarquin, the Proud, at the close of the 6th century before Christ, the Roman Republic began and lasted until 27 B. C., nearly five centuries. Of the early years of the republic little is positively known. Romance and tradition make up a large part of the story. In order to curb the growing power of the executive office, administrative authority was vested in two elected consuls, with limited tenure of office, but as had always been, the franchise still remained in the patrician class to the exclusion of the plebeians. No sooner was the republic fully established than a struggle for power began between the two classes and lasted for several centuries. The patricians endeavored to establish an exclusive aristocratic government on the ruins of the monarchy, and the plebeians demanded a large participation in common civic privileges. Slowly but surely the plebeians gained. Gradually the social and political barriers between the classes were broken down and by the 3d century before Christ, practically all distinctions in regard tto the franchise and office holding had disappeared. In 200 years the Romans emancipated themselves, first from kingly and then from oligarchal domination. During these and the ensuing centuries, constitutional changes were frequent, but until toward the end, generally to the enlargement of the powers of the people. Under this republican government, Rome arose to a civic distinction unparalleled at that time. The story of the city and state fills the most brilliant pages of ancient history. Her law is to-day largely the basis of law throughout the civilized world. She made herself mistress of the peninsula of Italy and then conquered the world. Her power became colossal and then her conquests proved her undoing. War made her a military nation and agriculture was neglected. The spoils of victory brought to her enormous wealth and created great fortunes for her soldiers. Inordinate extravagances followed and resultantly the condition of the poorer classes became more and more distressing. Reverence for law disappeared, many attempts were made by the aristocracy to control the power of the masses and the state became an arena on which men were merely contending for power, wealth and influence. The civil war in which Marius and Sulla were the leaders was the final struggle between the aristocratic and democratic elements. Constitutional government had been long forgotten and in the general distress all classes of citizens felt that a change of government with a strong man at the head was the only thing that could save the state. So Sulla was proclaimed dictator in 81 B. C. In form the republic endured for 50 years more under the consulships of Pompey, Cæsar, Crassus and Cicero, but it was little more than form. The dictatorship of Cæsar in 48 B. C. was another step toward the end, and Rome was ready for the empire when Octavius Augustus came to the head of the state and was proclaimed imperator in 33 B. C. Republican institutions more and more faded into the background during the life of Augustus and in all but name he was an absolute monarch. When Tiberius succeeded to the throne, Rome was an empire in reality.

Mediæval Republics.— Coming to mediæval times, there were the Lombard communes, the independent cities of Italy, the free cities of Germany and Iceland, all of which had republican forms of government. Lombardy, in the north of Italy, was a separate kingdom, part of the Carolingian empire, or annexed to the German Empire until near the close of the 10th century. Then arose a number of independent duchies, as Mantua, Susa, Piedmont and others and several independent cities that in the 11th century became republics. Among these were: Florence, Milan, Padua, Piacenza, Treviso, Modena, Cremona, Vicenza, Bologna, and others. In them municipal organization grew up independent of church or empire that had heretofore dominated. Consuls were elected by the citizens and arts, crafts and guilds had part in the control of affairs. Between these cities there was no firm federal compact but in times of danger they formed powerful leagues for mutual defense. But although they grew in wealth, power and influence, their governments were never stable. They quarreled with each other and were torn by internal dissensions, constantly shifting between the power of the people and the power of the few. The history of Florence, which remained longest the champion of constitutional liberty, is a story of centuries of contention between the forces of democracy and oligarchy. One by one these cities finally fell before the assaults of foes, were incorporated into kingdoms, duchies or principalities, becoming, in some instances, possessions of Austria and finally were incorporated into the kingdom of Italy. In the 10th century Genoa established a free constitution. During the next two centuries the republic increased in wealth and power. A world-wide commerce was established, and many of the large cities of Southern Europe and Asia came under her control, as Marseilles, Nice, Venice, and Constantinople. At the outset, the constitution of the state leaned toward an aristocracy. A bitter antagonism between conservatism and democracy developed, changes of government became frequent, and in 1339 the citizens elected a doge for life. Three centuries later Genoa yielded to Austria and then to France, by the treaty of Vienna became a tributary city of the Sardinian monarchy and ultimately a part of the Italian kingdom. Venice had an independent government in the middle of the 6th century, her rulers being called military tribunes. From 697 to 755 the elected chief magistrate was the doge, whose authority was well-nigh imperial. Universal suffrage existed, but during the season of the republic's greatest prosperity, wealth and aristocracy for the most part administered public affairs. In time the democracy demanded more rights and privileges and in the 11th and 12th centuries the strife between the aristocracy and the commonalty was determined and bitter. In 1172 the government became essentially a patrician oligarchy with constantly increasing power, and in 1298 popular elections were abolished by the Great Council. Further encroachments upon the civic rights of the people, expensive wars with sister republics and selfish legislation of the oligarchy undermined patriotism, and for four centuries the classes fought with each other. In 1674 the oligarchy yielded to the commonalty and for another century the republic continued in varying fortune until Napoleon, in 1797, placed it under the domination of Austria. Amalfi, on the west coast of Southern Italy, was an independent city of 50,000 inhabitants in the 9th century and the capital of a flourishing republic. Toward the close of the 11th century Amalfi was subjugated by the Normans.

Later Struggles.— The larger towns and communities of northwestern Europe gradually freed themselves from the exactions of feudal lords and became independent. From the beginning of the 12th century they established a large commercial intercourse between themselves and with the world. To protect themselves against marauders and to develop their commercial interests, they formed the Hanseatic League in the 13th century. Hamburg, Lubeck, Bremen, Frankfort and Cologne were the principal cities in this league, but city after city joined the union until it embraced 85, and in power matched the strongest governments of Europe. These cities were sovereign states and, while part of the German confederation or empire, they exercised full authority in their local affairs. In the Hanse confederacy they held the Baltic in dominion and controlled the foreign commerce of Northern Europe. The league lasted until 1630 although previous to that date it had been shorn of its powers. Most of the cities had been absorbed into the German kingdoms or principalities and at last only Hamburg, Lubeck, Bremen and Frankfort remained independent. In 1813 these four became free members of the German confederacy, but in 1866 Frankfort fell to Prussia. Hamburg, Lubeck and Bremen still retain their freedom in local affairs, being governed by chambers of representatives elected by popular vote. Iceland was settled by exiles from the tyranny of the princes of Norway, Denmark and Scotland, in the 10th century and a republican form of government was established in 928. At the head was placed a supreme magistrate, elected by the people and sharing authority with a general assembly. This form of government lasted for nearly 400 years and Iceland attained to civilization and a measure of prosperity. But internal dissensions sprang up and civil wars devastated the island. In 1621 the national council, by common consent of the people, invited Haco, King of Norway, to become Iceland's ruler and in 1380, again by common consent and peacefully, the island was transferred to Denmark. During the 10th, 11th, 12th, and 13th centuries, the whole of Belgium and Bavaria was split up into small dominions. In 1383 the house of Burgundy obtained control of this territory, which afterward became the 17 provinces of the Netherlands. Following the Burgundian rule came the long struggle with Spain, which ended in 1648 with the peace of Westphalia, by which the independence of the Republic of the United Provinces was acknowledged by the great powers of Europe. The provinces had formally united, with William of Orange as stadtholder, in 1580. The republic continued through many vicissitudes for two centuries, the people enjoying political freedom and the nation acquiring a high degree of power and prosperity. European politics could not withhold its hand from the Netherlands, and the Dutch provinces were in constant turmoil within and engaged in war without. In 1747, through all these influences, William IV. was made captain and admiral-general of the whole union and stadtholder of the seven provinces: a little later these offices were made hereditary in both the male and female lines. At the time of the French Revolution, the stadtholder was driven out by the French and the old republican forms of government re-established, but in 1814 the people recalled the Prince of Orange from his exile in England and established the monarchy, under William I., King of the Netherlands.

France.— The first French republic had an inglorious career of 12 years. It began with the overthrow of the monarchy in 1792, and ended with the crowning of Napoleon as Emperor of France, in 1804. The 12 years of this republic were 12 years of terror. A state of anarchy existed, not a state of government. It was a despotism of a democratic mob united with the despotism of a democratic dictatorship. When the passion of the hour had burned itself out and Robespierre, Marat, Danton, and other leaders had fallen, France turned again to a monarchy for self-preservation. For the second time the people, in 1848, overthrew the monarchy and re-established a republic. The king, Louis Phillippe, abdicated and fled to England and a new constitution was adopted, providing for a president, a council of state, and an assembly elected by popular vote. Louis Bonaparte was elected the first president, and in 1852, by an almost unanimous vote, he was accepted as hereditary emperor under the name of Napoleon III. The second empire lasted for 18 years and was succeeded by the third republic in 1870, which was in stable and unthreatened existence in 1905. The defeat of France by Germany in 1870 led to the overthrow of Napoleon III., and the Napoleonic dynasty. For more than a third of a century now France, the republic, has steadily grown in wealth and power, and is reckoned as one of the strongest nations of Europe. Its government is a pure democracy and authority is vested in a president elected for seven years, by the Congress and a Senate and Chamber of Deputies elected by the people, the latter by popular vote, and the former by an electoral body.

Switzerland.— Besides France there are now three republics in Europe. The most important is that of Switzerland. The Swiss republic dates from 1291, when the men of Uri, Schwyz and Unterwalden entered into a defensive league. Other cantons were added to the league until, in 1798, under the influence of France, the Helvetic Republic was formed with a regular constitution. In 1815 the perpetual neutrality of Switzerland and the inviolability of her territory was guaranteed by the powers of Europe. The republic is non-centralized, each canton having independent local powers. The federal government consists of a state council of members elected by the separate cantons and a national council elected by the people as a whole. The president and the vice-president are elected for terms of one year by the federal assembly. Universal suffrage prevails and the compulsory referendum and popular initiative are features of legislative procedure.

Andorra.— Andorra, in a valley of the eastern Pyrennees, between France and Spain, is under the joint suzerainty of these two countries, It was declared a free state by Charlemagne and has always retained its independence. It is governed by a council of 24, elected by the people, and the chief executive is a member of the council, elected for life by his associates. It has a population of less than 10,000.

San Marino.— San Marino, in Italy, is the oldest existing republic in the world. It embraces five villages with a population of about 8,000. The general government is intrusted to a council of 60, the chief officer being termed Captain-Regent.

The United States.— On the western hemisphere, with the exception of the Dominion of Canada and the smaller dependencies of Great Britain, France and Denmark, every country is under a republican form of government. The United States of America is the oldest of these republics, the most extensive in territory and the largest in population. It stands among the world's greatest powers and in its influence it dominates the western world. As a nation, the United States originated in the colonies of Great Britain that existed in the eastern, middle and southern sections of the New World in the 18th century. The inhabitants of these colonies were mostly of English origin but they rebelled against the rule of the mother country and united in establishing themselves as a free nation, under the Declaration of Independence in 1776. In form of government, the country is a non-centralized republic, and its constitution and form of government have been the pattern upon which all republics have been modelled since its beginning. The president, who serves for a term of four years, is chosen by an electoral college, the members of which are elected by popular vote in the several states and represent the state-at-large and its congressional districts. The Senate consists of two members from each state, elected bv the state legislature. The House of Representatives consists of members elected by popular vote in the separate congressional districts in the several states. There is a federal judiciary and in foreign relations, interstate commerce, army and navy affairs, navigation and postal service, the federal government is supreme. Each state is wholly independent in the control of its own affairs, having a form of government like the federal, a governor, upper and lower houses of legislation and state judiciary. The nation has had a prosperous existence. It had been engaged in wars with England, France, Mexico and Spain, and passed through a civil war, 1861–5, the greatest that the world has ever known. It has expanded until now it covers the northern part of the hemisphere from the Atlantic to the Pacific and from Canada on the north to Mexico on the south. As a result of the Spanish-American war, the republic entered upon a colonial policy and extended its operations across the Pacific. It acquired the Philippine Islands by the treaty of 1898 and also the islands of Porto Rico and Guam, and all three have been held as colonial dependencies. Hawaii, whose white citizens had revolted from native monarchial rule and set up an independent republic, was annexed to the United States in 1898 as a territory. For centuries the island of Cuba was under the misrule of Spain. Insurrection followed insurrection against the Spanish power, but Cuba was held fast as a Spanish colony until the Spanish-American war, of which it was the cause. In the peace treaty between the United States and Spain, Cuba was relinquished. It was temporarily held by the United States pending the establishment of a stable home government, but in 1901 this was accomplished and in the following year, with Tomas Estrada Palma at its head, free Cuba took its place as the latest republic in the world. Universal suffrage with educational qualifications prevails, and the form of federal government and methods of election follow closely those of the United States of America.

South America.— The South American republics are ten in number, Argentine, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay and Venezuela. Early in the 16th century Spain invaded and subjugated Peru and achieved a conquest of almost the entire South American continent. For three centuries she was able to master and hold not only that portion of the hemisphere, but also territories of Mexico and Central America and a great part of what is now the western and southwestern section of the United States. In South America she divided power only with Portugal. In the first quarter of the 19th century most of the South American states achieved their independence and established themselves under republican forms of government. The agitation for emancipation broke out almost simultaneously in different parts of the continent but was not always quickly or easily successful. In 1810 the Chilians revolted against the king of Spain and a junta which met at Santiago elected the Marquis de la Plate, a native Chilian, president of the republic, but it was not until 1818 that independence was formally proclaimed. A constitution was voted in 1833. The Argentine provinces freed themselves from the Spanish yoke in 1810, but were immediately embroiled in disputes and contentions among themselves. The history of the republic is a record of anarchy, civil contentions and warfare with European nations and sister republics. The existing constitution was adopted in 1853. Paraguay gained its independence in 1811, and after a short period of government by two councils, the supreme power was seized in 1815 by Dr. Jose Gaspar Rodriguez Francia, who exercised autocratic sway as dictator until his death in 1840. A state of anarchy followed and lasted two years, after which a National Congress put two consuls at the head of affairs. The dictatorship of President Lopez followed, and in 1870 a new constitution was voted, making the country a full-fledged republic. Bolivar, the liberator, began his work for freeing South America from the Spanish yoke in 1809. After alternate defeat and success, he finally triumphed, and in 1819 united New Granada and Venezuela as a republic under the name of Colombia. In 1832 the republic split up into Venezuela, Ecuador and New Granada, and after several changes in constitution and in state membership, the country became, in 1886, the Republic of Colombia. In 1820 San Martin, at the head of an invading army from the republic of Chile, entered Peru, drove out the Spanish authorities and proclaimed himself Protector. Two years later Simon Bolivar, at the request of San Martin, entered the country and was appointed Dictator. Under Bolivar, Peru achieved her full freedom. A succession of civil wars and constitutional changes followed during a period of over 30 years. A constitution, in the modern spirit, was proclaimed in 1856 and under it the republic has continued since. In 1825 the republic of Bolivar was instituted from the southern province of Peru by Simon Bolivar and named after its founder. The constitution that was then formed underwent important modifications in 1828, 1831, 1863 and 1880. For nearly two centuries the territory of Uruguay was the subject of almost constant contention between Brazil and Buenos Ayres. In 1828, by the mediation of England, the northern part of the territory was ceded to Brazil and the southern part was erected into the republic of Uruguay, having declared its independence three years before. The constitution was established in 1830. The republic of Ecuador was constituted in 1830, as the outcome of a civil war, which separated the members of the original republic of Colombia formed by Simon Bolivar upon the ruins of the Spanish kingdom of New Granada. Its constitution was voted in 1844 and modified in 1887. Venezuela also had its origin in 1830 in the break up of the Bolivar republic of Colombia. The Spanish flag was cut down in this province in 1811 and the struggle against Spain was carried on until 1823, when the Spanish troops were completely expelled. The charter of fundamental laws was put in force in 1830 and has been several times modified. Of all the South American countries, Brazil remained longest under a monarchy. It was an apanage of Portugal until 1815. The royal family of Portugal fled to Brazil in 1807 and establishing the throne there, the colony was declared a kingdom in 1815. When the royal family returned to Portugal in 1821, Brazil declared itself independent with Dom Pedro, son of Don Joao VI., of Portugal, as Emperor. The throne came to Dom Pedro II. in 1831, and he ruled until 1889, when by a revolution he was deposed and with his family exiled to Europe. Brazil was declared a republic under the name of the United States of Brazil. In origin, in career, and in form of constitutional government, the South American republics show striking similarity. The cry for liberty expressed in the French Revolution and more especially the successful establishment of the republic of the United States of America inspired the patriots of the southern part of the hemisphere to the struggle for freedom. In establishing constitutional government, they took pattern from the United States of America. Universal suffrage with age and educational qualifications prevails. The central government in each republic consists of a president and two legislative branches, a senate and a house of representatives, or house of deputies. Methods of electing the president and members of the senate and the house vary somewhat, but directly or indirectly the principle of the rule of the people is adhered to. The states or provinces that constitute each republic generally have full freedom in their local affairs, although in several republics federal officers have more or less control. Theoretically the South American governments are non-centralized republics. Practically the federal government is a strongly centralized power. The population may be broadly divided, as far as government is concerned, into two classes, the ignorant and indifferent, and the ambitious and turbulent. Consequently the history of these governments has been almost uniformly a story of intrigue, revolution, sanguinary civil war and domestic upheaval. Presidents have held themselves in power by bayonets, usurpers have arisen supported by the army, and dictators have ruled under the name of presidents and nominally so elected. Nearly all of the republics are laden heavily with debts and are in frequent controversy with their foreign creditors. Brazil and Chile are the most stable and most promising of these republics.

Central America.— The Central American republics are Costa Rica, Guatemala, Honduras, Nicaragua, San Salvador and Panama. Central America, after freeing itself from Spain in 1821, until which time it was known as the kingdom of Guatemala, was attached to the kingdom of Mexico. In 1823, Guatemala, Honduras, Nicaragua and San Salvador formed an independent federal union, under the name of the United States of Central America. Subsequently the states dissolved this alliance and became independent, Guatemala in 1847, Honduras in 1839, Nicaragua in 1858, Costa Rica in 1829 and San Salvador in 1853. These republics are republics only in name. Each has a constitutional government and popular suffrage. In form the federal authority consists of a president, and two legislative houses. In fact, the government is always in the hands of a few strong men who exercise autocratic power. Revolutions are frequent, the factions resort to arms whenever desire or opportunity impels, and there is no security of life or property. Panama, which may, perhaps, be considered as belonging almost as much to South America as to Central America, was originally part of the republic of Colombia. When the latter country hesitated in coming to an understanding with the United States in regard to the construction of the Panama canal in 1903, the department of Panama seized the opportunity to secede from her associate. There was a bloodless revolution of a few days. Panama declared itself an independent republic and was recognized at once by the United States. Now that the work upon the Panama canal through its territory has been begun, it is practically under the protection of the United States.

West Indies.— In the West Indies is an island on which there are two nominal republics, known as the black republics. Hayti, governed first by Spain and then by France, became free in 1793. First the free colored population gained the franchise in 1791 and then all the negroes in 1793 under the leadership of Touissant l'Ouverture, acquired freedom. In the last century the island had varying fortunes, sometimes under English, French or Spanish domination, twice an empire and several times republican. San Domingo republic, on the eastern end of the island, was established in 1844. The government is in the hands of an elected president and two legislative houses, but control of affairs is constantly being changed by revolutions and the setting up of dictatorships. The republic of Hayti, on the western end of the island, has a similar history, under a like form of government proclaimed in 1867. In both republics the government is in the hands of negroes and mulattoes who constitute almost the entire population.

Mexico.— From the time that Cortes conquered Mexico, 1518–20, that country remained in the hands of Spain for three full centuries. Finally in 1810 rebellion broke out and Iturbide, the liberator, was proclaimed emperor. Upon the death of Iturbide, the army organized a republic and Mexico was entirely freed. For nearly half a century there was only the merest semblance of government of any kind. The history of the period is a record of anarchy, intrigue, revolution, military leaderships and dictatorships. In 1857 a constitution was formed, but the existing condition of internal disorder did not terminate. The French made war against Mexico and Maximilian was created emperor by a provisional government in 1862. Upon the execution of Maximilian in 1867 the republic was more firmly established but it was not until as late as 1878 that under Porfirio Diaz the country became settled. Mexico is a federative republic, divided into states, each of which manages its own local affairs, while the whole are bound together by fundamental and constitutional laws. The powers of government are exercised by a president, senate, house of representatives and judiciary.

Africa.—On the western coast of Africa is the republic of Liberia, which represents an attempt made by American philanthropists to prove the capacity of the negro race for self-government. Founded in 1820 by the American Colonization Society, it was organized as an independent state in 1847 and acknowledged first by England and other nations of Europe and by the United States in 1861. The constitution of the republic is copied from that of the United States and the right of suffrage is inalienable to every male citizen who owns real estate. As no white man can be admitted to citizenship, and as none but citizens can hold real estate, the republic is in absolute control of men of the African race. It is a fairly prosperous country but is heavily loaded with debt and has been constantly torn by political disorder. Executive power is vested in a president and legislative power in a senate and house of representatives. In the southern part of Africa the Boers of Dutch origin founded two republics. The Orange Free State was established by Boers who in 1836 and following years quitted Cape Colony in order to separate themselves from British rule there. In 1854 the independence of the republic was declared and a constitution proclaimed. The legislative authority is vested in a single popular assembly elected by the suffrage of adult white males having property qualifications. The president is elected by universal suffrage. Similar to the history of the establishment of the Orange Free State is that of the South African Republic, known also as the Transvaal. It was formed by Boers who moved from Cape Colony and Natal and in 1852 its independence was acknowledged by Great Britain. A constitution was adopted in 1858. There was never lasting peace between the Transvaal and its British neighbors to the south. In 1877 the country was annexed to Great Britain, but the Boers gained their freedom again under the treaty of 1881. Great Britain acquired suzerainty over the foreign relations of the republic in 1884. Friction between the two countries continued unceasingly and finally culminated in open war in 1899, which resulted in the defeat of the Boers and the addition of the republic to the South African possessions of Great Britain.

Duration of Republics.—It is not easy to set down in each case precisely the length of years that these republics have existed. Among historians there are differences, in most instances, as to the dates of beginning and ending. Some authorities date from the physical overthrow of a monarchy or other form of government preceding, others from the commencement of the struggle for popular rights, others from the adoption of a constitution and so on. Some accept as the end the accession of king or emperor, or the actual establishment of a new form of authority, while others hold that the republic really became non-existent before those events occurred to finally and formally mark its disappearance. Frequently the birth or the death of a republic has been a gradual development extending over many years, so that it is almost impossible to fix the exact time when it was fully fledged, or, on the other hand, had passed away completely. Some republics, noticeably those of South America and Central America, have had interrupted careers, republican rule in them being frequently suspended for a few months or even years, while dictators have held power although in form, at least, it has been practically continuous. Others have begun as members of a republican federation and later have been established entirely independent. Venezuela, Colombia and Ecuador were originally united in the one republic of Colombia; Guatemala, Honduras, Nicaragua and San Salvador were first members of a federal union. It is a disputed question whether such republics should be considered as dating from the beginning of the federation or from the beginning of their individual independence. In the appended table the former view is generally taken; approximately then, the duration of life of the world's republics is as follows‘:

Israelitish Commonwealth	1491-1095 B. C.	396 years.
Grecian republic	700-146 B. C.	554 years.
Carthage	850-146 B. C.	704 years.
Rome	535-29 B. C.	506 years.
Lombard Communes	1183-1530	347 years.
Genoa	1000-1802	802 years.
Venice	600-1796	1196 years.
Amalfi	900-1135	235 years.
Free Cities of Germany	1241-1630	389 years.
Hamburg	1630-1912	287 years.
Lubeck	1630-1912	287 years.
Bremen	1630-1912	287 years.
Frankfort	1630-1810	180 years.
Iceland	928-1261	333 years.
The Netherlands	1609-1805	196 years.
French Republic I	1792-1804	12 years.
French Republic II	1848-1852	4 years.
French Republic III	1871-1912	41 years.
San Marino	885-1912	1027 years.
Andorra	790-1912	1122 years.
Switzerland	1291-1912	621 years.
Liberia	1820-1912	192 years.
Orange Free State	1854-1912	58 years.
South African Republic	1849-1903	54 years.
United States of American	1776-1912	136 years.
Mexico	1824-1912	88 years.
Venezuela	1819-1912	93 years.

Colombia	1819-1912	93 years.
Ecuador	1819-1912	93 years.
Peru	1821-1912	101 years.
Bolivia	1825-1912	87 years.
Paraguay	1811-1912	101 years.
Argentine	1810-1912	102 years.
Uruguay	1825-1912	87 years.
Chile	1810-1912	102 years.
Guatemala	1823-1912	89 years.
Honduras	1823-1912	89 years.
Nicaragua	1823-1912	89 years.
San Salvador	1823-1912	89 years.
Costa Rica	1821-1912	91 years.
Brazil	1889-1912	23 years.
Hayti	1804-1912	108 years.
San Domingo	1844-1912	68 years.
Cuba	1903-1912	9 years.
Hawaii	1894-1912	18 years.
Panama	1903-1912	9 years.
Portugal	1911-1912	2 years.
China	1911———	— years.

Of these 48 republics 33 were in existence in 1912. Taken altogether, history shows that these nations have been as stable, prosperous, influential and powerful under republican forms of government as under monarchial or other form. No dynasties can compare in years of existence with the 12 centuries of Venice, the 11 centuries of Andorra, and the 10 centuries of San Marino. Few can show longer life than the republics of Israel, Carthage, Greece, Rome, Genoa, Switzerland and the Hanse cities of Germany. The ancient republics of Greece, Carthage, Rome, Lombardy, Venice and Genoa were the greatest nations of their times. In art, literature, law, commerce, all that goes to make up the best of modern civilization, they led the world for more than a thousand years, and left a heritage of good for all mankind coming after them, such as can be credited to no monarchy. The death of those that have gone out of existence was not, as is claimed by some, due to defects peculiar to the republican form of government. It came about naturally from the condition of things in the civilization of the earlier centuries. Men were warlike in those days, unrestrainedly contentious and regardless of the rights of others; public and private affairs were turbulent; class distinctions were sharply defined. Under such conditions all governments were, for the most part, short lived. Monarchies and oligarchies suffered as well as others. One after another they rose and disappeared, and none of them, until comparatively recent centuries, endured as long as the republics that were contemporary with them or that succeeded. The older republics deteriorated in public spirit toward the end; they were torn by internal dissensions; they became the prey of extravagance, dissolution and idle wealth within their borders, while jealous neighbors constantly sought to plunder and destroy or subjugate them. But these were dominant evils of the day in all lands and it stands to the credit of republican institutions that, despite disintergrating forces constantly at work, they existed long and splendidly. In modern times the story has been much the same. Only Great Britain, Germany, France, Italy, Austria, Denmark and two or three smaller monarchies can show results comparable with contemporary republics, and in those countries constitutions have given the people almost as much voice in public affairs as in a republic. Even in South America and Central America where government is still more or less chaotic and uncertain, the republics are in every way an improvement upon the despotic rule of Spain that they succeeded. The first French republic was undisguised anarchy; the second was merely in comparison, a temporary flurry, but the third suffered in no wise with the most brilliant decades of the French kingdom or empire. The United States of America, under republican form of government, in all that goes to make up a great nation, has advanced to the forefront of world powers. Brazil has been as well governed in the decade and a half of its republican existence as it was even under the last Dom Pedro, most beneficent and most democratic of monarchs. The lesson to be drawn from the history of these republics is that men are able to govern themselves well. The dangers and evils that may threaten the republic have always been and are now the dangers and the evils inherent to the period, and threatening to any government, republican or otherwise. The elasticity of republicanism, permitting of easier adaptation to changing conditions and readier conformity to the needs of the people, gives it an advantage over the more rigid monarchy. That the general trend of the 19th century was toward republicanism cannot be questioned. Nearly half the republics that history tells of were started then and all of them are now in existence. At the beginning of the 20th century more than one-half of the territory that is included in the civilized world belonged to republics and fully one-third of the population in all the civilized countries lived under republican rule. Portugal and China are the latest countries to adopt a republican form of government, and republican agitation is active in Spain and Italy.

Repu'diation, originally an American term, now used in all English-speaking countries, signifying the refusal of a national or state government to pay real or alleged pecuniary obligations. Nearly all leading countries have, at some time in their history, repudiated indebtedness. England has never repaid money borrowed for public uses from a Florentine merchant by one of the Edwards, and prominent London bankers were ruined when Charles II. confiscated their funds deposited in the royal exchequer. France redeemed the paper money called assignates at one thirtieth of its value. The United States failed to redeem the Continental currency. In the disastrous financial period of 1840 and several subsequent years, the States of Illinois, Indiana, Pennsylvania, Maryland, Mississippi, Michigan and Louisiana suspended payment of interest on their debts incurred in promoting public improvements, but all of them, except Michigan, Mississippi, and Louisiana, eventually fulfilled their obligations as to the capital of the debt. Governor McNut of Mississippi advocated «repudiating the sale of certain of the State bonds,» on account of alleged fraud and illegality in the issue, and this was the origin of the term «repudiation» as applied to that course on the part of a State. The legislature of Mississippi refused to accept the governor's suggestion, but while the bonds were not formally repudiated, they were not redeemed. Michigan provided for the repayment of money actually received, repudiating obligations shown to have been issued without a fair equivalent, even although in the hands of innocent parties. Louisiana paid her creditors in depreciated State bonds. Minnesota refused to honor certain railroad bonds guaranteed by the State, in 1858, claiming that the railroads had failed to comply with the conditions on which the guarantee was given. The question of paying this indebtedness was agitated for many years, and finally in 1880 Minnesota compromised by agreeing to pay 50 cents on the dollar.

After the Civil War the Southern States fell under the rule of unscrupulous white men known as «carpet-baggers,» intruders from the North who took advantage of the prostrate condition of the Southern whites to obtain control of the State governments with the aid of ignorant negroes. In some instances, also, white natives of the South shared in the carnival of plunder and oppression. Obligations were issued for which no reasonable equivalent ever reached the State treasuries, and the impoverished communities, when the native whites obtained supremacy again, found themselves deeply in debt. Georgia, Virginia, North Carolina, South Carolina, Florida, Alabama, Mississippi, Louisiana, Arkansas, and Tennessee, either scaled their debts to a figure which represented value received, or refused to pay obligations alleged to be tainted with injustice and corruption. Under the 11th Amendment to the National Constitution States cannot be sued by individuals, and creditors are therefore powerless to attempt collection in the courts. The repudiated obligations of the Southern States are mostly locked up in Northern safes, being held by persons who hope that at some period in the future the States in question may follow the example of Minnesota, and decide, notwithstanding alleged fraud and illegality, to redeem the promises to which the State seal is affixed.

Spanish-American republics, with some honorable exceptions, have persistently ignored their financial obligations. An attempt by France, England, and Spain, to collect debts due by Mexico, was the cause, or more correctly the excuse, for the ill-fated effort to establish an empire in Mexico, with Maximilian on the throne. Since the growth of Mexico in prosperity and position among the nations, under the beneficent despotism of Diaz, the Mexican government has voluntarily taken steps to meet its financial obligations. Venezuela's indifference to foreign claims led to the blockade of Venezuelan ports in 1902–3 by Germany, Great Britain, and Italy, and The Hague Tribunal decided in February 1904 that the nations who took part in these warlike proceedings were entitled to preferential treatment in the settlement which Venezuela had agreed to make with all her creditors. This decision caused much dissatisfaction on the part of the United States government, as it was apprehended that it would encourage the collection of debts by European powers from the weaker American republics by violent methods.

Repulsion, in physics, the force which compels certain bodies or their particles to recede from each other. No repulsion exists between bodies at sensible distances, except when they are in certain electric or magnetic states, in which case the repulsions between them are in the inverse ratio of the square of the distance. At insensible distances, some influence keeps the particles of a body from being in absolute contact, whence results the phenomenon of elasticity. The motions produced by heat are also a cause of strong molecular repulsion. The molecules of gases are always in a state of mutual repulsion.

Reputed Ownership, in law, is a phrase used of one who has to all appearances the right and actual possession of property. «The false credit raised by a person exercising all the rights of ownership over a subject not his own has led to the adoption of the rule that the creditors of the reputed owner may take the subject as if it were his own.» See BANKRUPTCY.

Requeña, rā-kā'ñä, Spain, town in the province of Valencia, 40 miles west of Valencia. The remains of the tower of the ancient church of San Salvador; the castle towering above Las Cabrillas (a prominent summit), and the ruins of walls which formerly surrounded the city. are the chief points of architectural interest. The chief industry consists in the culture of silk, saffron, grain, fruit, and wine. Pop. 14,500.

Reredos, rēr'dŏs, in church architecture, usually the screen back of the altar, which is adorned with sculptured work comprising the tabernacle, niches, statuary, and the like; in some great cathedrals, for example, in England, the cathedrals of Durham, Winchester, and St. Albans, the reredos is a mass of most elaborate carving which reaches nearly to the graining.

Res Judicata, rēz joo-dĭ-kā'tā, a law term meaning that the subject matter of an action has been already decided by a court of competent jurisdiction. A matter so decided cannot again be made a ground of action between the same parties.

Resaca, rā-sä-kä, **Battle of.** While the armies of Gens. Thomas and Schofield were threatening an advance from the north on Dalton, Ga. (q.v.), Gen. Sherman ordered Gen. McPherson, commanding the Army of the Tennessee, to move southward through Snake Creek Gap and interpose between Dalton and Resaca. McPherson moved from Gordon's Springs 8 May 1864, his advance bivouacked that night in the Gap and next morning pushed through it, defeated a brigade of Confederate cavalry at the eastern end of it, and approached to within a mile of Resaca, on the Oostanaula, where he found the enemy in position too strong to be attacked; and being unable to find a good road by which he could quickly reach the railroad, north of Resaca, and fearing an attack upon his own left flank, he prudently withdrew, after some severe skirmishing, and took a strong position near the east end of Snake Creek Gap. Sherman now resolved to transfer the greater part of his army to join McPherson. Howard's Fourth corps and a small force of cavalry were to demonstrate on Buzzard Roost Gap and occupy Confederate attention north of Dalton. On the 10th Hooker's Twentieth corps moved through Snake Creek Gap and joined McPherson. Palmer's Fourteenth corps and Schofield's Twenty-third corps followed, and on the 12th the whole army, except Howard's corps and the cavalry with it, was through the Gap. On the morning of the 13th McPherson, preceded by Gen. Kilpatrick's cavalry, led the advance on the direct road to Resaca. Thomas, with the corps of Palmer and Hooker, was to move on McPherson's left, and Schofield on the left of Thomas. The country was covered by dense forest, and the movement of troops was difficult. Kilpatrick drove the Confederate cavalry to within two miles of Resaca, and was wounded, and his cavalry wheeled out of the road, allowing McPherson to pass, who, encountering the Confederate pickets near Resaca, drove them in and occupied a range of bald hills, his right on the Oostanaula, about two miles below the railroad bridge, and his left abreast the town. Thomas came up on McPherson's left and faced Camp Creek. Schofield worked his way through dense forest and came up on the left of Thomas, but it was noon of the 14th when these movements were completed, at which time Howard's Fourth corps, following Johnston from Dalton, had reached a position about a mile north of Schofield's left. Johnston abandoned Dalton about midnight of the 12th, and during the 13th formed his army covering Resaca, Polk's and Hardee's corps west of the place, facing west and covering the railroad bridge and a trestle bridge. Polk rested his left on the Oostanaula, and Hood's corps, on the right of Hardee's, extended across the railroad to the Connesauga, facing to the northeast. Wheeler's cavalry was on the right, and Jackson's cavalry, on the left, guarded the Oostanaula from Resaca to Rome. There had been severe skirmishing on the afternoon of the 13th between the troops of McPherson and Polk, and it was renewed on the morning of the 14th, and in the afternoon McPherson carried a bridge on Camp Creek, crossed it, and secured a commanding position very close to Polk's main line and intrenched. Confederate efforts to retake the position were repulsed. Farther to the left Palmer's Fourteenth and Schofield's Twenty-third corps became severely engaged with Hardee on Camp Creek, parts of Schofield's corps were repulsed with great loss, another part succeeded in making a lodgment beyond the creek. Two divisions of Howard's corps, coming in from the north, were sent to Schofield's support, leaving Stanley's division in echelon to the left. Hooker's corps was sent to the left. Johnston had noted the exposed position of Sherman's left and ordered Hood, with the divisions of Stewart and Stevenson, to attack and turn it. Late in the afternoon Hood attacked Stanley, outflanked him, and was driving him back when the advance of Hooker's corps, Williams' division, came up, repulsed Hood and drove him back to his intrenchments. Skirmishing was resumed along the entire line on the morning of the 15th, and Sherman ordered an advance of Hooker on the left, and the two divisions of the Twenty-third corps were withdrawn from the centre and marched to the extreme left in support. It was after noon when Hooker advanced, Butterfield's and Geary's divisions on the right and centre, and Williams' on the left. Hood, with the divisions of Stevenson and Stewart, supported by three brigades from Polk's and Hardee's corps, made a simultaneous advance from his works. Stevenson on his left was struck first by Butterfield and then by Geary, before he had gone far from his works, and after a severe fight was driven back to them, leaving a four-gun battery in advance of his line, which remained between the two lines until night, when it was secured by a detachment of Geary's division. On Hood's right Stewart's division swung to the left, drove Williams' skirmishers from the railroad and, crossing, assaulted Williams' main line most vigorously, but was bloodily repulsed and fell back to its intrenchments. A part of Schofield's corps on Hooker's left took part in this engagement. Hooker's loss was over 1,600. On the 14th Sherman had ordered a pontoon-bridge to be thrown across the Oostanaula at Lay's Ferry, in the direction of Calhoun, and Sweeny's division of the Sixteenth corps was ordered to cross it and threaten Calhoun. Sweeny crossed one brigade, drove some Confederate cavalry from the opposite bank, then hearing that the Confederates were crossing above him, he withdrew the brigade and retired his entire division half a mile to a less exposed position. On the morning of the 15th he moved back to the river and crossed it, laid a pontoon-bridge, and constructed works. Here he was fiercely attacked by Walker's Confederate division, which was repulsed. The presence of a part of Sherman's army east of the Oostanaula determined Johnston to retreat, and that night he abandoned Resaca and marched for Calhoun. Sherman occupied Resaca on the morning of the 16th and started in pursuit. The Union loss at Resaca was about 600 killed and 2,147 wounded. The Confederate loss was about 300 killed, 1,500 wounded, and 1,000 missing. Consult: ‘Official Records,’ Vol. XXXVIII.; Cox, ‘Atlanta’; Van Horne, ‘History of the Army of the Cumberland,’ Vol. II.; Sherman, ‘Personal Memoirs,’ Vol. II.; The Century Company's ‘Battles and Leaders of the Civil War,’ Vol. IV.; Johnston, ‘Narrative of Military Operations.’

E. A. Carman.

Resaca de la Palma, rā-sä'kä dā lä päl'mā, Texas, a ravine in Cameron County; four miles north of Brownsville. On 9 May 1846, an engagement took place here between 2,300 Americans under General Taylor, and 5,000 Mexicans under General Arista. The Americans were victorious; their loss was 39 killed and 83 wounded. The Mexican loss was 200 killed, 228 wounded, and 100 missing. Consult: Howard, ‘Life of General Taylor’; Bancroft, ‘History of Mexico.’

Re'script, the term applied in Roman law to the answers of popes and emperors to questions in jurisprudence propounded to them officially. The rescripts of the Roman emperors constitute one of the authoritative sources of the civil law. These were usually addressed to the provincial magistrates, to corporations, or even to individuals. The rescripts of Justinian admitted into the code have acquired great authority. The rescripts of the popes concern principally theological matters.

Rescue, or Schrader's Brome Grass. See Grasses in the United States.

Resection, in surgery, the operation of cutting out the diseased bone of a joint. It frequently obviates the necessity of amputating the whole limb, and by the removal of the dead parts leaves the patient a limb which, though shortened, is in the majority of cases better than an artificial one. Resection, which is one of the triumphs of modern surgery, became a recognized form of surgical operation in 1850.

Reservation of the Eucharist, the keeping of the sacramental species against emergent occasions, as the communion of the sick in their homes, for the Mass of the Presanctified on Good Friday, for the rite called Benediction of the Blessed Sacrament, and for perpetual adoration. Mention is made in authors of the times immediately following the apostolic age, of the custom of bishops sending to one another the Eucharist in token of Christian union and fraternity. St. Ambrose (4th c.) tells of the Eucharist being carried by lay persons; in the Middle Ages this custom was still in vogue. Thomas à Becket carried the Eucharist with him when he went to meet Henry II. and Saint Louis carried the sacred species with him on his crusade. The sacred host is now customarily reserved in all Catholic churches whether of Latin or Oriental rite, being kept usually in the tabernacle of the high altar in the Latin Church, and in Greek churches in a special receptacle, *artophorion,* behind the altar: whenever it is reserved, a lamp is kept ever burning before it.

Reservation, Mental, in moral theology and ethics, the withholding from speech words that are necessary to convey the sense in which the speaker wishes his interlocutor to take his words: in general, Mental Reservation is the using of words in a sense other than that which is obvious and which the speaker knows they are likely to convey: this is commonly called equivocation. Is Mental Reservation or equivocation ever lawful? The obligation to speak truth is acknowledged by all moralists, Catholic and Protestant alike; all theologians agree in the cardinal doctrine that it is never lawful to lie. But, mental reservation or equivocation has the same effect as lying: can resort, then, be made to equivocation without sin? «Almost all authors,» answers John Henry Newman (*Apologia*, Append.), «Catholic and Protestant, admit that *when a just cause is present,* there is some kind or other of *verbal misleading* which is not sin.» The Catholic casuist is bound by authoritative decisions of the Roman See to hold that equivocations and mental reservations that *cannot be perceived* by the hearer are forbidden by the law of God: but nearly all Catholic moralists teach that sometimes a mental reservation is lawful, which may be, though very likely will not be, understood from the circumstances: on this ground a priest may deny that he knows of a crime which he has learnt through sacramental confession. Newman mentions various modes of verbal misleading which have received the sanction of moralists: one is the straightforward way of saying the thing that is not, as when one gives false direction to one who intends murder; authors hold that veracity is a kind of justice, and therefore when we have no duty of justice to tell truth to another, it is no sin not to do so. Another defense of certain untruths resorted to for just cause is, that veracity is for the sake of society, and, if in no case we might lawfully mislead others, we should actually be doing society great harm. On the other hand, certain strict moralists hold that all equivocations are in their nature lies, and therefore under no circumstances may we without sin equivocate. And then there is the rough-and-ready way of dealing with lies, namely, that of admitting that on a great or cruel occasion a man cannot help telling a lie, and he would not be a man did he not tell it. «This view cannot for a moment be defended,» Newman remarks, «but, I suppose, it is very common.»

Reservation, Papal, of Benefices, the taking of the bestowal of certain church benefices and dignities out of the hands of the local church rulers and the attribution to the Roman Pontiff of the right to confer the same; or, what amounts to the same thing, the requiring of bishops, chapters and other persons or ecclesiastical bodies possessing the right of conferring benefices, that in case of vacancies they should bestow such benefices on persons nominated by the Pope. One reason alleged in favor of this practice was that thus the several national churches were linked more closely by personal ties of gratitude and affection to the central see, and through it to each other; another was that thus the Supreme Pontiff was provided with the means of rewarding those who had labored meritoriously in the cause of the Holy See and the Church Catholic.

Reservations, Indian. When the settlers from Europe came to realize that the Indians had human rights, and ought not to be enslaved or exterminated, the rule was generally adopted of confining the tribes to reservations, both for their own protection from unprincipled whites, and for the security of the white population. New York, Massachusetts, Connecticut, Rhode Island and other States enforced this policy in the colonial period and after independence, and the United States government has carried it out from an early date. Southern tribes east of the Mississippi were removed to the Indian Territory, designated by solemn pledge of the National government as a permanent home for their race, and there some of the tribes have achieved a high degree of civilization, and gained considerable wealth. They are largely intermarried with whites, and to some extent with negroes, whom they formerly held as slaves. Other tribes, chiefly from the Southwest, have been gathered into the Indian Territory, but large Indian reservations, mainly of Sioux, are still maintained in the Northwest, and altogether the various tribal reservations in the different States and Territories number about 185. The reservations are carefully guarded against intrusion by unscrupulous whites, and provision is made for the intellectual and physical welfare of the Indians, and for leading them to adopt civilized methods of self support, instead of depending on the chase, which now offers only the most precarious returns, or on government aid, which, however, is not withdrawn under any circumstances while an Indian is in need of it. The sale of intoxicating liquor to Indians is severely punished when detected, but the law is frequently evaded.

Reserve, in military affairs, has several significations. In battle the reserve consists of those troops not in action, and destined to supply fresh forces as they are needed, to support those points which are shaken, and to be ready to act at decisive moments. Napoleon's guards, and his disposition of them, are models. They often decided the victory when the enemy felt sure of success. The reserve of ammunition is the supply of warlike stores placed close to the scene of action to allow of the supply actually in the field being speedily replenished.

The term reserves is also applied to those forces which are liable to be called into the field on great emergencies, for the purposes of national defense; which have received a military training but follow the ordinary occupations of civil life, and do not form part of the standing army. Such reserves now form a part of all national troops organized on a great scale. The militia of the various States is practically a reserve force for the National Government in the event of war.

Reserved Cases, in the canon law of the Roman Catholic Church, certain sins the power of absolving from which is reserved to the ecclesiastical superior himself — the pope, the bishop, the ruler of a monastery or other religious house. The «faculties» conferred regularly on priests who administer the sacrament of Penance do not extend to reserved cases, and the penitent must sue personally or through an intermediary for absolution by the pope, bishop or other superior to whom the case is reserved. Bishops have the right to limit the absolving power of those who under them have cure of souls, but in the United States this right is seldom exercised, and the «faculties» accorded in this country to rectors of churches and other *confessarii* is practically as large as that possessed by the ordinaries themselves.

Res'ervoir, a receptacle for storing water for any purpose, but more commonly for supplying cities and towns, feeding canals, driving machinery, and the like. The construction of a reservoir is of much importance, and requires great engineering skill. In the selection of a site the great object should be to choose a position which will give the means for collecting a large supply of rainfall with as little recourse as possible to artificial constructions. An advantageous site would be, for instance, in the narrow gorge of a valley through which a stream passes, and at a place where the gorge widens out on the side looking toward the source of the stream. Particular care, however, is necessary to discover whether the position chosen communicates with the courses of underground waters or springs, as disastrous results have frequently been occasioned by ignoring this. As a general rule the best and safest method is to establish reservoirs in valleys filled in with clays derived from the decomposition of the primary formations, which are very slightly permeable. The embankments or dams may be constructed either of masonry or earth-work, the latter being generally the more economical method. Where the reservoir requires to be constructed on perfectly level ground the excavation should be calculated so as to equal the embankment. The earth-work of dams should be as much as possible of material — such as a mixture of clay and gravel — which would resist the infiltration of the water; but as it is impossible always to obtain such material in sufficient quantities, engineers have recourse to a device which consists in the construction of a kind of wall termed a *puddle-wall,* formed in the middle of the embankment. This wall is constructed of well-worked clay, the foundation of the puddle being a trench dug down to impervious rock or clay, and its breadth should be on an average about one third the height of the embankment. The inside slope of the embankment is usually 1 perpendicular to 3 horizontal, sometimes it is steeper; the outside slope is 1 perpendicular to 2 horizontal; and the height above the surface of the water is 4 to 7 feet. The earth-work ought to be constructed of thin layers, carefully rammed so as to secure their equal settlement; the inner face requires to be protected by stones in order to resist the action of the water. The waste-weir, to admit of the surplus water flowing over, should be from 4 to 6 feet below the surface line of the embankment, built of strong masonwork, and of a width such that with a flow of 2 feet over the crown it should be able to discharge all the water brought down by the severest floods ever known to fall upon the basin supplying the reservoir. Many of the accidents that have occurred were due to deficiencies in the waste-weirs. In the reservoirs of which the dams are built of masonry there is no necessity for a waste-weir, as then the water may be allowed to overflow the wall, there being no fear of its endangering the work. The outlet at the bottom, by which the water to be used is drawn off from the reservoir, may consist either of a tunnel, culvert, or iron pipes provided with suitable sluices, and these should be so constructed that access may be had to them even when the reservoir is full.

The true principles for the proportioning of masonry dams were not thoroughly investigated until about the middle of the 19th century and subsequently. This was first done by French engineers, and many such dams have since been constructed in France, Algeria, the United States, etc. The highest of all such dams is that of the New Croton reservoir, New York, its height being 248 feet; thickness at bottom, 185 feet; at top, 16. The first great masonry dam built in France on the newer principle was that of Furens (1860–5); height, 184 feet; thickness at bottom, 162; at top, 11. The San Mateo reservoir dam near San Francisco, is 170 feet high; thickness at bottom, 176; at top, 20. The Periyar dam, India (1890–5), has a height of 173 feet; bottom thickness, 139; top, 12. In the famous reservoir of Alicante, Spain, executed 1579–94, the wall is 67 feet thick at the top, 112 feet at the bottom, and the height 141 feet. In England the preference is generally given to earthen dams. Sometimes natural lakes are used as reservoirs, instances of which are Loch Katrine, for the water supply of Glasgow, and Lake Thirlmere, in Cumberland, for the supply of water to Manchester. Distributing reservoirs for towns are generally built of masonry, but are sometimes of iron. They ought to be placed high enough to command the highest part of the town, and ought to be capacious enough to contain half a day's supply, their chief use being to store the surplus water during the night. Among notable modern storage reservoirs for towns are those of the Vyrnwy, for supplying Liverpool, containing 11,900 million gallons; Vehar (10,800 million gallons), for Bombay; San Mateo (31,000 million gallons), for San Francisco; and the New Croton (32,000 million gallons), for New York.

Resht, rĕsht, Persia, capital of the province of Ghilan, 150 miles northwest of Teheran, near the Caspian Sea, and with a port at Enzeli. On the highway of commerce and travel between Europe and Persia, its geographical position has a special significance. There is an extensive manufacture and trade in silk. Pop. about 40,000.

Residence, the place which a man regards as his home, even although he may be absent from it for long periods of time. In the United States the question of residence is of the greatest importance, involving citizenship, the right to vote, marital relations, questions of taxation, and of the disposition of property by will or inheritance. It has therefore frequently engaged the attention of the courts, and the decisions have not been uniform. As a rule a man is assumed to reside where his family have their home, provided he is not separated from them by law, and provided they have not refused to accompany him to a fitting residence elsewhere. When a man has a summer and a winter home, the question of residence is usually determined by his personal declaration, and his payment of personal taxes in the place which he elects to call his residence. Courts regard with suspicion and disfavor change of residence for the obvious purpose of obtaining a divorce, and New York courts have refused in several instances to recognize divorces granted in States to which citizens of New York had removed in order to take advantage of liberal divorce laws. Altogether the question of residence is far from being governed by any settled decision, but honest intent as shown by a frank and open course of conduct is usually respected by courts of law in passing upon the issue. See also HOUSE.

Resin. See ROSIN.

Resin Weed. See COMPASS PLANT.

Resistance, Electrical, that property of electrical conductors in virtue of which the passage of a current of electricity through them is necessarily accompanied by the dissipation of a part of the energy in the form of heat. It is manifested not only in a linear conductor like a wire, but also in solids of large extent in two or three dimensions, as when a current passes from one point to another of a sheet of metal, or of a mass like an ingot or casting. It is chiefly in connection with wires, however, that electrical resistance is of practical importance, and it is only in this aspect that the subject will be here considered.

The passage of a current of electricity through a wire or rod has been likened to the flow of a current of water through a pipe, the water corresponding to the electricity, and the friction between the water and the pipe to the electrical resistance of the wire. The analogy is not perfect, but it is certainly very useful in forming a good conception of electrical resistance. The energy of the moving current of water is gradually dissipated in the form of frictional heat, and the energy of the moving current of electricity is similarly dissipated on account of the electrical resistance of the conductor through which it is passing. The unit in terms of which resistance is measured is the «ohm,» which may be taken as sensibly equal to the resistance of a column of mercury 106.3 centimetres long and one millimetre in cross-section, at the temperature of freezing water. (For a more exact statement on this point, see UNITS.) The phenomena of electrical resistance have been studied, both mathematically and experimentally, by many eminent physicists; but the most important contributions to our knowledge are due to Georg Simon Ohm (for whom the «ohm» was named), and to James Prescott Joule. Ohm investigated the manner in which the flow of electricity through a conductor depends upon the resistance of the conductor, while Joule determined the law that governs the dissipation of energy from a conductor, in the form of heat. In the following exposition of the laws of Ohm and Joule, it will be assumed that the currents in the conductors are steady, that the electro-motive forces in the circuits are constant, and that the conductors are stationary (so that their coefficients of induction remain constant). The laws may still be applied, though in a somewhat more generalized form, to conductors in which these three conditions are not fulfilled; but for the proper understanding of the phenomena in such cases, it is necessary to refer to the more advanced treatises on electricity.

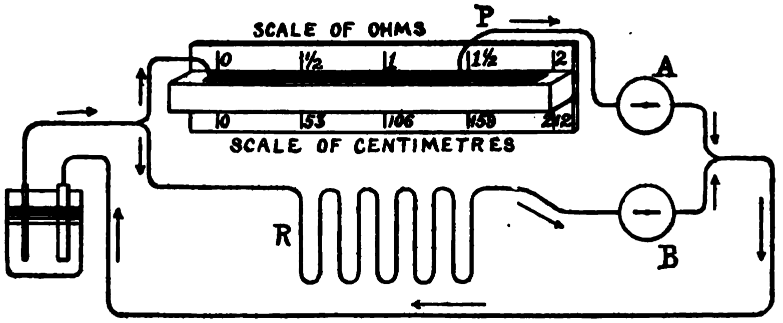

FIG. 1.

One of the results of Ohm's investigation was, that in a branched circuit, in which the resistances of the two branches are precisely equal, the current divides in such a manner that exactly one half of it traverses each branch. By taking advantage of this fact, we can determine the resistance of a proposed conductor in the following manner: Let *R*, in Fig. 1, be the resistance to be measured, and let this be placed in one of the branches of the circuit. In the other branch of the circuit is a standard column of mercury, whose cross-section is one square millimetre, and whose temperature is that of freezing water; the resistance of such a column being (as noted above) one ohm for (say) each 106 centimetres of its length. The mercury column is arranged so that the current enters it at the left hand end; and the current is led away from the mercury column again by means of the movable wire *P*, whose point of contact with the mercury can be shifted to the right or left, at will. The measurement consists in moving the point *P* until the two galvanometers *A* and *B*, one in each branch of the circuit, show that the currents in the two branches are precisely equal. We then know that the resistances in the two branches are also equal. In preparing the engraving it has beeen assumed that the equality has been observed to subsist when that part of the mercury column which is included in the circuit is 159 centimetres long, and therefore has a resistance of 1.5 ohms. If the galvanometers and connecting wires are identical in both branches, it therefore follows that the resistance of the coil *R* is also 1.5 ohms. The method of measuring resistances here described is presented in order to illustrate the fundamental idea of electrical resistance. In the practical measurement of resistances a more refined method, presently to be described, is employed.

It is found that the electrical resistance of a linear conductor of uniform cross-section is proportional (1) directly to the length of the conductor, (2) inversely to the area of its cross-section, and (3) directly to a certain numerical factor characteristic of each material, and which is called the «specific resistance» of the material. The specific resistance of a given metal varies to a certain extent with the physical condition of the metal. The following values are for annealed specimens, except in the case of lead and zinc, where pressed or extruded metal is understood; and the resistance of mercury has been taken as unity in each case. The temperature is also assumed to be that of freezing water, in every instance.

SPECIFIC RESISTANCES OF METALS.

Mercury	1.0000
Silver	0.0158
Copper	0.0168
Gold	0.0216
Aluminum	0.0306
Zinc	0.0592
Platinum	0.0952
Iron	0.1022
Nickel	0.1310
Lead	0.2063

In practice, mercury columns are not used as standards of resistance, because they are not convenient to manipulate. The mercury column is selected as defining the «ohm» for general purposes, because it is easy to obtain mercury in a state of purity, and also because all questions of internal stress and physical state in general are eliminated by the use of a fluid standard. An isolated observer, for example, who wishes to construct a resistance of one ohm for experimental purposes, can do so readily enough by preparing a column of pure mercury of known length and cross-section. He can then compute the resistance of this column, at the freezing point of water, and in this way he can obtain a standard of considerable accuracy. In practical work, however, it is customary to employ, as standards of resistance, coils of wire that are wound upon spools or bobbins. These are standardized either by comparison with other coils whose resistances are known, or by direct comparison with a mercury column of known dimensions and assured purity. A bobbin that is wound with wire as an ordinary spool is wound with thread possesses a considerable coefficient of self-induction if the length of wire is at all great; and this tends to impair its efficiency as a standard, because in the practical measurement of resistance it is desirable to have the self-induction of the standard as small as possible. Standard resistance coils are therefore wound in a special way, with the idea of reducing the self-induction as much as possible. One half of the wire is wound about the central core (or spool) in one direction, and the other half is wound in the other direction; so that if an iron core were placed in the axis of the spool, and a current were sent through coil, the magnetic effect upon the central iron core would be zero. By this device, the self-induction of the coil may be rendered negligible.

The resistance of a conductor varies to some extent with temperature; and while the magnitude of the variation differs with different metals, and even with the physical state of any one metal, it may be taken, roughly, as increasing by about 0.21 of one per cent, for each Fahrenheit degree of rise of temperature, for copper and silver and several of the other pure metals. The resistance of liquid mercury increases much more slowly with temperature, the coefficient of mercury being only about one fifth of that stated above. The resistance of carbon diminishes as the temperature rises. In accurate electrical work it is evidently essential, in view of the variation of resistance with temperature, either to keep the temperature of the standard coils constant, or to ascertain the coefficient of variation of resistance with temperature with considerable care, so that a suitable correction may be applied for any departure of the temperature of the standard coils from the one temperature at which their resistances are accurately known. In practice it is usual to determine the temperature coefficient with as much accuracy as possible, and then to keep the temperature of the coil as near as practicable to the temperature at which it has been standardized. Any error in the determination of the temperature coefficient will then have but small effect upon the calculated resistance of the standard. Many attempts have been made to prepare alloys which shall have negligible temperature coefficients; and while no alloy has been found whose electrical resistance is absolutely independent of the temperature, several have been prepared whose temperature coefficients are quite small. German silver is one of the commonest of these alloys, the composition of that which is used in the preparation of resistance wire being (by weight) 4 parts of copper, 2 of nickel, and 1 of zinc. The specific resistance of this alloy is about 13 times that of copper, and its temperature coefficient is only about 0.022 of one per cent, per degree Fahrenheit. «Platinum-silver,» as used for electrical resistance standards, is composed of two parts (by weight) of platinum, to one part of silver. It has a specific resistance about 15 times as great as that of copper, and its temperature coefficient, per Fahrenheit degree, is only about 0.017 of one per cent. «Manganin» has largely come into favor for electrical resistance standards during the past few years, the composition recommended by the Reichsanstalt being (by weight) 84 per cent of copper, 12 per cent of manganese, and 4 per cent of nickel. Its specific resistance is about 20 times that of copper, and its temperature coefficient is only about 0.0013 of one per cent, per Fahrenheit degree, at ordinary temperatures; the coefficient diminishing as the temperature rises, until, at about 113° F., the coefficient becomes rigorously zero. At still higher temperatures, the coefficient of manganin becomes negative; but at all temperatures it is so small that it can be neglected for all purposes save those in which the highest attainable degree of accuracy is required.

In the accurate measurement of electrical resistances, the device known as "Wheatstone's bridge" is employed. Ohm's law, which is one of the most fundamental principles in the science of electricity, states that in any circuit of constant form, in which a constant electromotive force is acting and a uniform current is flowing, the current, resistance and electromotive force are connected by a simple mathematical relation, which may be expressed in the following manner: Let any two points in the circuit be selected, and let R be the resistance included between these points, as expressed in ohms. Let E be the electromotive force between these same points, as expressed in volts; and let C be the current between them, in amperes. Then the relation in question is $C=\frac{E}{R}$, or $E=CR$. To apply this principle to the measurement of resistances, let A and B, in Fig. 2, be the two points selected, and let the circuit be divided at these points, into the two branches AHB and AKB; the resistance of AH being P, while that of HB is Q, that of AK is S, and that of KB is T. The points H and K are to be connected, later, by means of a conductor, HGK, carrying a galvanometer, G; but for the moment the conductor HGK is assumed to be non-existent. Let us suppose that the difference in electromotive force between A and B is E, while that between A and H is e. Then Ohm's law, when applied to the branch AHB as a whole, gives $E=C_1(P+Q)$; C_1 being the current flowing through the branch AHB. Similarly, when applied to the section extending simply from A to H, Ohm's law gives $e=C_1P$. Eliminating C_1 from these two equations, we find that e, the electromotive force between the two points A and H, is equal to $EP/(P+Q)$. In the same way we may show that the difference of electromotive force between A and K in the branch AKB is equal to $ES/(S+T)$. If the electromotive force between H and K is zero, then these two expressions are equal, and we have $P/(P+Q)=S/(S+T)$, which is equivalent to $Q/P=T/S$, or to $PT=QS$. If H and K are connected by a branch conductor that includes a delicate galvanometer, G, then the galvanometer will indicate a current except when the electromotive force between H and K is zero; that is, it will show a current whenever the relation $PT=QS$ is not fulfilled. This arrangement of branch circuits, with a galvanometer bridging across from one of the branches to the other, constitutes "Wheatstone's bridge." Its use for measuring resistances may be illustrated as follows: Let Q and T be two known resistances, and let P be the unknown resistance, whose value is to be determined. At S we introduce a "resistance box," which is merely a box containing an assortment of known resistances, so arranged that any or all of them can be conveniently thrown into the circuit or out of it. The resistance S is varied by trial until the galvanometer G ceases to show a deflection; and when this condition is fulfilled, we know that the equation $PT=QS$ holds true. But we knew Q and T to start with, and we have determined S by trial; so that we know three of the four resistances that enter the foregoing equation, and we can therefore calculate the fourth. Resistances may be determined, in this manner, with exceeding accuracy. (Consult, for full details, W. A. Price, 'Treatise on the Measurement of Electrical Resistance.')

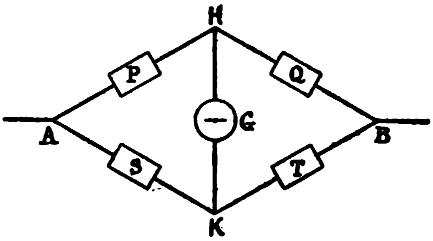

FIG. 2.

One practical application of Ohm's law relates to the arrangement of the cells of a battery, so that the current goes through all of the obtained in a given circuit, by the use of a fixed number of cells. If the zinc electrode of one cell is joined to the carbon electrode of another, a compound element is thereby formed, which has twice the electromotive force of a single cell, and whose internal resistance is also twice as great as the resistance of one cell. Similarly, if n cells be arranged in series, so that the carbon of each is connected to the zinc of the next, and so that the current goes through all of the cells consecutively, the electromotive force of the battery will be nE (where E is the electromotive force of one cell), and the resistance of the battery will be nr (where r is the resistance of one cell). If the terminals of this battery be connected by means of a wire whose resistance is R, the total resistance of the circuit so formed will be $R+nr$; and hence the current through the circuit will be (in accordance with Ohm's law)

$$\text{Current}=\frac{nE}{R+nr}.$$

If R, the resistance of the external part of the circuit, is very small, it is evident that the current will not be very different from E/r; that is, if the external resistance is very small, the current sent through it by the battery of n cells arranged in series, will not be greatly different from the current that would be obtained by the use of a single cell. But if R is very large, so that nr is negligible in comparison with R, then the current through the external circuit becomes sensibly equal to nE/R, which is approximately n times as great as the current that a single cell would send through the given external circuit. When the resistance of the external circuit is great, therefore, the maximum current is obtained by arranging the cells of the battery in "series," as described above.

If the n cells are arranged so that all of the carbons are connected together to form one electrode, and all the zincs are connected together to form the other one, then the electromotive force of the battery is the same as that of a single cell. That is, it is r/n. The external internal resistance of n cells arranged in this way, however, is only one nth of the resistance of a single cell. That is it is r/n. The external resistance being R, as before, the total resistance of the circuit is $R + r/n$, and hence the current in the external circuit is

$$\text{Current} = \frac{E}{R + r/n}.$$

If the external resistance, R, is large, then r/n will be negligible, and the current becomes practically E/R, which is approximately equal to the current that a single cell would send through the same large external resistance, R. On the other hand, if the external resistance, R, is very small, R may be negligible with respect to r/n, and in that case the current through the external resistance becomes nE/r, which is sensibly n times as great as the current that a single cell of the battery would send through a very small external resistance. When the resistance of the external circuit is very small, therefore, the maximum current through it is obtained by arranging the cells of the battery «in parallel»; — that is, so that all of their carbons are connected to form one positive electrode, and all their zincs are connected so as to form one negative electrode. In general, it may be shown that the maximum current that any given battery can produce through a given conductor, is realized when the cells are so arranged that the effective internal resistance of the battery is as nearly equal as possible to the external resistance through which the current is to be sent.

The quantity of energy dissipated in the form of heat when a current traverses a conducting circuit was investigated by Joule, and also by Lenz, Becquerel, and others. It is found that the quantity of heat-energy set free in any given conductor in one second is proportional (1) to the resistance of the conductor, and (2) to the square of the current that is flowing. If the resistance of the conductor is R ohms, and the current is C amperes, then the quantity of heat generated in T seconds will be $0.238\, C^2RT$ calories; the «calorie» being defined as the quantity of heat required to raise the temperature of one gramme of water from 14° C. to 15° C. This is often called «Joule's law.»

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Resolution Island, the name of several islands, the principal one being in British North America, at the extreme end of Hudson Strait; lat. 61° 39′ N.; long. 65° W. The island is about 40 miles in length and breadth, and Cape Resolution is on the east side. Resolution Island, in Dangerous Archipelago, Pacific Ocean, is in lat 17° 22′ S., long. 141° 35′ W. Resolution, a lagoon island in Low Archipelago, is in lat. 17° 25′ S., long. 143° 24′ W.

Resolu'tioners, a designation of party which had its origin in Scotch church history. When the Scotch with their covenanted king, Charles Stuart (Charles II.) had been defeated by Cromwell at Dunbar (13 Sept. 1650), the Scotch parliament repealed an act under which royalists were excluded from the army. The repealing act was approved by a large majority of the Scotch Kirk as being wise and politic in the circumstances, but it was reprobated by a small but zealous minority in the Kirk as a betrayal of the true interests of religion; this party was known as that of the Protestors, the other party as that of the Resolutioners; each of the two maintained that it was itself the genuine Scotch Kirk, the only church that remained faithful to the Covenant and to the church's head, Christ.

Resolutions of '98, the designation commonly given to the Kentucky and Virginia resolutions of 1798, defining the relations between the State and Federal governments, and protesting against certain acts of Congress as unconstitutional, and as violating the rights reserved to the States. The Resolutions offered in the Kentucky legislature, and adopted by that body, were drafted by Thomas Jefferson, who, in common with other leading American statesmen, and the majority of the people, was alarmed by the enactment of the Alien and Sedition Laws, and other measures regarded as indicating a purpose to create a centralized despotism in place of the Union formed under the Constitution.

The first Resolution declared that the Federal Constitution was a compact between the States, by which a general government was created for special purposes, and that, «as in other cases of compact between parties having no common judge, each party has an equal right to judge for itself, as well of infractions as of the mode and measure of redress.» The Alien and Sedition and other laws were pronounced «not law, but altogether void and of no force,» and one of the Resolutions postponed to «a time of greater tranquillity» the «revisal and correction» of other acts of Congress alleged to be unconstitutional.

The eighth Resolution directed the appointment of a committee of correspondence, to communicate the Resolutions to the several States, and to inform them that the State of Kentucky was determined «to submit to undelegated and consequently unlimited powers in no man or body of men on earth; that in the case of an abuse of the delegated powers, the members of the general government being chosen by the people, a change by the people would be the constitutional remedy; but when powers are assumed which have not been delegated, a nullification of the act is the right remedy; and that every State has a natural right, in cases not within the compact, to nullify of their own authority all assumptions of power by others within their limits.» The Committee of Correspondence was instructed to request the other States «to concur in declaring those acts void and of no force, and each to take measures of its own for providing that neither these acts, nor any other of the general government, not plainly and intentionally authorized by the Constitution, shall be exercised within their respective territories.»

The Resolutions passed the Kentucky legislature, 14 Nov. 1798, with only two or three dissenting votes, and similar Resolutions, drafted by James Madison, were adopted by the Virginia legislature, 24 Dec. 1798, by a vote of 100 to 63 in the House of Delegates, and 14 to 3 in the Senate. The fact that both Jefferson and Madison were afterward elected Presidents of the United States, and that the Democratic party, which they represented, remained in power for many years, has been accepted as indicating that the Kentucky and Virginia Resolutions had the substantial approval of the American people. See UNITED STATES.

Res'onance, a strengthening of sound. When a person speaks in an empty room the walls reflect the words. There is an echo from each wall; and when the person is not equidistant from the different reflecting surfaces the echoes strengthen one another, and strengthen the sound. Resonance includes such strengthening of sound as occurs when a sounding-board is used to strengthen the note from a string or the note of a tuning-fork, or when the air contained in an open-mouthed vessel is made to vibrate and strengthen a particular note.

Resorcin, or **Resorcinol,** a chemical substance having the formula $C_6H_4(OH)_2$, and therefore belonging to the group of phenols (q.v.). It may be regarded as derived from benzene, C_6H_6, by replacing two of the hydrogen atoms by two hydroxyl radicals. Three substitution compounds of this character are possible (see AROMATIC COMPOUNDS), and all three are actually known. Catechol (or pyrocatechin) is the «ortho» di-substitution product; resorcin is the «meta» di-substitution product, and quinol (or hydroquinone) is the «para» di-substitution product. Resorcin was first prepared by Hlasiwetz and Barth, in 1864, by fusing galbanum resin with caustic potash. It is now prepared commercially by fusing caustic soda with the sodium salt of benzene-meta-disulphonic acid; this acid being itself prepared by the action of fuming sulphuric acid upon benzene. The resorcin that is formed is abstracted from the solution so obtained by agitation with ether, or with some other substance in which the resorcin is soluble, but which does not itself mix with water; and after isolation in this manner, the resorcin is purified by distillation or otherwise. Resorcin is soluble in water, in alcohol, in benzene, and in ether, and is insoluble in carbon disulphide and in chloroform. From water, alcohol and ether it crystallizes in trimetric tablets, and from benzene it is obtained in the form of needles. Pure resorcin is colorless, but upon exposure to the air it becomes reddish. It melts at 244° F., and boils at about 520° F. Resorcin, like ordinary phenol (or carbolic acid), is largely used in the manufacture of the coal tar colors (q.v.), and it is also used extensively in medicine. It has marked antiseptic properties, and is used in the treatment of skin diseases in washes, ointments and salves. It is also administered internally, though less commonly.

Respiration. The essential process in respiration is the taking in of oxygen and the giving out of carbon dioxide by the living cells of a plant or animal. In higher animals special organs, the lungs (q.v.), and a special tissue, the blood (q.v.), are the main factors in this exchange; but in the lower animals lungs are not necessary, and in plants, as well as in many of the lower animals, there is no true blood. Even in those higher animals in which the major part of the oxygen exchange takes place in the lungs (external respiration), there is also an internal respiration constantly taking place in the exchange between the blood, the lymph, and other tissues. Respiration in plants is of the same general character as in animals. It is not to be confounded with the much more active process of photosynthesis, by which plants utilize carbon dioxide and give off oxygen, a process which was termed respiration by the older plant physiologists.

Historical Summary.—The earliest naturalists and philosophers, Aristotle and others, even down to the anatomists of the 15th century, taught that the function of respiration was to draw air into the arteries and heart, and thus to cool the blood. The old Galenic doctrine was that the «air introduced by breathing served to regulate, to maintain, and at the same time to temper, to refrigerate the innate heat of the heart.» Again the pumping action of the thorax introduced into the blood the air which was necessary to generate the vital spirits in the left side of the heart, and finally the same pumping action got rid of the foul vapors, the product of the innate fire burning in the heart. Harvey was one of the first to show that the same channel probably did not serve to carry these two different currents. But the chemical problems involved were too intricate for Harvey, although it was chiefly through the work of a group of Englishmen of the 17th century that the unraveling of the mystery of respiration came about. Von Helmont had taught a theory of fermentations, and he had noted the difference in color in blood passing through the lungs. Borelli approached the mechanical side of the problem and showed the truth regarding the mechanics of the chest, the bellows-like action of which took in by atmospheric pressure and expelled the air by the muscular relaxation and the elasticity of the chest-walls. Malpighi had in the meantime discovered, with the aid of his crude microscopes, the minute structure of the lung, and Borelli, as well as others (Hooke, 1667; Croon and Boyle, 1666), working with the newly discovered principle of the air-pump and vacuum, had learned that air was absolutely essential to the life of the animal, and had advanced to the point that the particles of the air taken into the lungs enter into and become mixed with the blood. But Borelli was a physicist, and had no sympathy with the new chemical learning, which was then a very vague subject. Hooke and Lower made the next steps possible, the former by his artificial-respiration experiments, proving the necessity for air, and the latter by his careful transfusion experiments, demonstrating that the difference between dark venous blood and lighter arterial blood was due to the admixture of air, thus explaining this color change, which had been recorded for thousands of years and referred to thousands of causes. Up to this time it had always been thought that the air was a simple substance, and not a mixture. John Mayow (1643) first showed that not all of the air was used by the lungs in influencing the blood, but only a certain part; and although he called it by a different name (nitro-aerial gas), it was that part now known as oxygen. Mayow thus developed the first full adequate physico-chemical theory of respiration. He saw that respiration was a process analogous to combustion, and that the movements were to take in the nitro-aerial gas and give out the vapors arising from the blood. But he did not know at all what these vapors were. He had grasped at the meaning of the intake, but had no knowledge of the exchange products. This and other wonderful discoveries were made by a young man of 25, and who died at the age of 34. Mayow's work was then forgotten for almost 100 years. As Foster expresses it, «that which in the first years of the latter half of the 17th century as igneo-aerial particles shone out in a flash and then died away again into darkness, in the last years of the 18th century, as oxygen, lit a light which has burned, and which has lighted the world with increasing steadiness up to the present day.» The names of Stahl, Haller, Boerhaave appear as keeping alive the study of respiration. Stephen Hales, an active parish priest, and the earliest sanitarian, was an ardent student of chemistry. He first enunciated the principle of free and combined gases, and led the way to the work of Joseph Black, who rediscovered Von Helmont's «fixed air,» which was given off by the lungs, and that animals placed in the «fixed air» died much as if they were deprived of fresh air. The next step was made by Priestley, who in 1772 rediscovered Mayow's «igneo-aerial» spirit and isolated oxygen. Priestley's views, however, were permeated by the century-old phlogiston theory, and it remained for Lavoisier clearly to demonstrate what oxygen really was and to overthrow the phlogiston theory. Thus the problem of animal respiration was solved. The air, composed mostly of innocuous nitrogen and of small proportions of active oxygen, passes into the fine air vesicles, first seen by Malpighi, the blood there takes up the free oxygen, giving off carbon dioxide, which exchange constitutes the essential feature of respiration. It should be added that it was not until Gustavus Magnus (1837) proved the presence of the blood-gases in different proportions in the blood that the present theory of respiration assumed a definite form. The study of the relation of the iron of the hæmoglobin in the blood to this oxygen exchange constitutes the last chapter in the unraveling of this secret of nature.

Mechanics of Respiration.— Breathing consists in the rhythmical expansion and contraction of the walls of the chest, by means of which process air passes into the lungs and thus comes in contact with the blood. The lung structure itself possesses no marked expansile power, but it is in a constant state of tension, there being negative pressure in the pleural cavity. The muscles attached to the ribs, including the diaphragm (q.v.), expand the cavity of the chest in all three diameters by raising the ribs and lowering the diaphragm; the air rushes in and inflates the lungs; the muscles then relax, the elasticity of the ribs causes the chest-wall to contract, the lungs themselves contract somewhat and the air is forced out through the bronchi and larynx. Thus it is evident that the lungs themselves are merely passive agents in inspiration, being filled and emptied of air largely in consequence of the movements of the chest-wall. The control of the muscular movements is partly voluntary and partly involuntary, and the breathing centre so called is in reality a complex one, or rather a series of centres, all co-ordinated. Thus the motor centres for certain muscles attached to the ribs are located in the spinal cord, and their excitation can bring about restricted movements of expansion, while their destruction may result in paralysis of certain of the muscles of respiration. Another breathing centre, the most important one, spoken of as the automatic or true respiratory centre, is found in certain ganglion cells in the floor of the fourth ventricle of the medulla oblongata (q.v.). Their destruction destroys the co-ordination of the muscular movements, and brings about death. A third centre is present in some portion of the fore brain, probably in the frontal lobes. It is this centre that enables one to «hold the breath,» or to make extra deep breaths, etc. The distinction between conscious and unconscious breathing is very distinct and yet very subtle. Voluntary influences constantly modify the rate of breathing. While one is asleep these conscious influences are usually temporarily excluded, and then the so-called normal rhythm is seen. This is usually from 18 to 20 to the minute in the adult, the ratio of length of inspiration to that of expiration being about 10 to 12. Numerous individual variations may be present, however, the rate varying from infancy to old age, and in diseased conditions the rate is nearly always modified, usually quickened in consequence of the increased oxidation that often accompanies disease. Occasionally respiration is slowed when there is painful breathing, or some form of poisoning; opium-poisoning is a noted illustration. In this condition the breathing rhythm may sink as low as 4 to 5 to the minute. In children of both sexes the movement of breathing are similar, but as adult conditions develop, and changes in dress become pronounced, it happens that women are more apt to breathe more in the chest (costal breathing), while men make more use of the lower ribs and the diaphragm (diaphragmatic or abdominal breathing). The amount of air taken into the lungs varies widely with the size of the individual, the shape of his chest, and a number of other factors that make it impossible to give a general average. It is usual to measure that portion of air that passes in and out of the lungs during normal respiration as tidal air; this has been known to be from 150 to 700 cubic centimetres. In forced breathing a certain extra amount of complemental air can be taken into the chest; its average being about 1,500 cubic centimetres. A certain amount of air (residual air) cannot be expelled from the chest even by forced expiration. This has been found to vary in amount from 400 to 1,500 cubic centimetres. The vital capacity, or the amount of air which can be expelled from the thorax by forced expiration following a deep inspiration — a spirometer, or the «lung-tester» of the circus, being the instrument for measuring the same — varies very widely according to practice, height, weight, and age. For the comparative anatomy of respiration, see ANATOMY, COMPARATIVE, *Respiratory System*.

Artificial Respiration.— When death is imminent, owing to a cessation of the natural respiration movements, it may sometimes be averted by an imitation of them carried on regularly for a while. Such a condition may occur in disease (for example, asthma, epilepsy), though very rarely; it is most common in suffocation, either by drowning, choking, or strangulation, and is sometimes met with also in poisoning by noxious vapors (for example, carbonic acid, carbonic oxide, coal-gas, chloroform, etc.). In order that any method may have a chance of being successful it is of course necessary that the entrance of air into the lungs be not impeded, whether by a piece of food or by water in the windpipe, or by the tongue falling back and closing the upper opening. A piece of food may sometimes be removed through the mouth by the finger; if this fails, the windpipe should be opened. In those apparently drowned the body should first be laid on the face, with the head low, and the thorax and abdomen be pressed on in order to expel fluids which may have been drawn into the trachea and bronchial tubes. The tongue may need to be held forward; this may be done by an assistant; or an elastic band passed round the tongue and the chin will effect the object. No general concensus of opinion has yet been arrived at as to which is the best method of producing artificial respiration. The methods most employed fall into three divisions: (1) insufflation, or blowing of air into the lungs, either by the mouth or by means of bellows; (2) manual methods, in which external manipulations of the chest-walls are made to effect the entrance and exit of air; (3) electrical stimulation of the respiratory muscles. In all cases where artificial respiration is required every moment is of importance. It is doubtful whether life can ever be restored when the heart has ceased to beat for more than a few seconds; and when breathing has stopped failure of the heart's action is always imminent. That method is therefore best which can be applied with the least possible loss of time, so that under ordinary circumstances the methods which require bellows or electric batteries are out of the question. Direct insufflation, or blowing of air into the patient's lungs by the mouth applied to his mouth, is now hardly ever used except in the case of very young children, although within recent years specially devised pumps have been made that are at times very serviceable. Of the manual methods those most in use are Marshall Hall's (1856), Silvester's (1857), and Howard's (1877). The second is certainly the most easy to learn, but is more fatiguing to carry out for a length of time than either of the others. In Marshall Hall's method the body is laid upon its face and rolled «in what may be termed cradle-fashion» from this position on to one side and a little beyond it (inspiration), and then back on to the face (expiration). In Silvester's method the patient is laid on his back on a plane, inclined a little from the feet upward, and the shoulders are gently raised by a firm cushion placed under them, which also throws the head back. The operator then grasps the patient's arms just above the elbows, and raises them till they nearly meet above the head. This action imitates inspiration. The patient's arms are then turned down, and firmly pressed for a moment against the sides of the chest. A deep expiration is thus imitated. In Howard's method the patient is laid on his back with a cushion below the middle. The operator kneels astride his hips, places his hands with fingers spread outward over the lower part of the chest-wall, and alternately bends forward, throwing his weight on the chest to imitate expiration, and springs back to allow the elastic recoil of the chest-wall to imitate inspiration.

Whatever method be adopted, the movements must be gentle, regular, and perseveringly carried on, at the rate of from 10 to 15 times in the minute; and when the faintest natural effort at respiration is observed they must at once be timed so as to reinforce and not to oppose it. In some cases life has been restored under artificial respiration when no respiratory movements have occurred for an hour or even several hours. In all cases, but especially in that of persons apparently drowned, artificial respiration should be conducted in a warm atmosphere, 90° F., or even more if possible, and should be supplemented by warmth applied to the body and by vigorous friction. In those apparently drowned recovery is very rare after complete immersion for as much as five minutes. If stunning or fainting has occurred at the moment of immersion, so that the respiratory movements have been annulled or much diminished for the time, less water will have entered the lungs, and the chance of recovery may be greater. In other modes of death by suffocation, such as choking or strangulation, the action of the heart may continue longer, and restoration to life be therefore possible after a longer deprivation of air. See Asphyxia; Drowning.

Consult: Bert, ‘Leçons sur la Physiologie comp. de la Respiration’ (1870); Foster, ‘Lectures on the History of Physiology’ (1901); Schäfer, ‘Text-Book of Physiology’ (1901). See Anatomy; Hæmoglobin.

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Respirator, an instrument used as a mouth-covering to give warmth to the air inhaled into the lungs. They are also frequently employed to secure the inhalation of a medicated atmosphere, containing a layer of lint or wool on which a few drops of terebene, eucalyptol, or other antiseptic are placed.

Responden'tia, a term now seldom used, but meaning a loan raised by the master of a ship, when he has no other means of doing so, upon security of the cargo or goods on board the ship. The contract has reference to a particular voyage, and the conditions are that if the subject on which the money is advanced be lost by sea, risk, or superior force of the enemy, the lender shall lose his money; and that if the goods arrive in safety the loan shall be repaid with a greater than ordinary rate of interest, called marine interest. When the ship itself is hypothecated the contract is called bottomry. As a matter of fact the expression bottomry is employed, whether the vessel or her cargo or both be the security.

Ressel, rĕs'sĕl, **Joseph,** Austrian inventor: b. Chrudim, Bohemia, 29 June 1793; d. Laibach, Austria, 10 Oct. 1857. He was educated at Vienna and at Mariabrunn, and from 1817 until his death was employed in the Austrian Department of Forestry. He was skilled in mechanics and invented several machines. His claim to the invention of the screw-propeller seems as well founded as those of Ericsson, Sauvage, Smith, and Wilson, but owing to an accident on the trial trip of his invention he failed to secure a patent. Consult Reitlinger, ‘Joseph Ressel’ (1863).

Rest-cure, a method of treatment advocated by Dr. S. Weir Mitchell in 1875 for cases of nervous prostration and various conditions characterized by poor blood, and lack of muscular and nervous tone. It is a systematic treatment extending over several weeks, a combination of absolute rest of body and mind, regular diet at fixed hours, a separation from relatives and friends, passive exercise by massage, the use of electricity, and the supervision of a trained nurse. The use of medicines is of secondary importance, but frequently of value. As Dr. Mitchell puts it, the rest-cure is of service to «invalids, unable to attend to the duties of life, and sources alike of discomfort to themselves and anxiety to others.» Consult Mitchell, 'Fat and Blood' (1877).

Res'tarick, Henry Bond, American Protestant Episcopal bishop: b. Somersetshire, England, 26 Dec. 1854. He studied at the King James collegiate school in Bridgewater, England, and after coming to this country was graduated from Griswold College, Davenport, Iowa. He took priest's orders in the Episcopal Church in 1882, was rector of St. Paul's Church, San Diego, Cal., 1882–1902, and in July of the last named year was consecrated the first American bishop of Honolulu. He has published 'The Love of God'; 'Addresses on the Seven Last Words.'

Restigouche, rĕs-tĭ-goosh', a river of Canada, in its lower course separating New Brunswick from the province of Quebec, and flowing northeast into the Bay of Chaleur at Dalhousie. It rises in eastern Quebec, is 225 miles long, is navigable for 16 miles to Campbelton, and forms a tidal estuary for 24 miles. It drains 6,000 square miles, and its basin supplies great quantities of timber.

Restitu'tionists, a Christian religious sect in New England whose distinguishing tenet is that the restoration of mankind to the condition from which he lapsed through Adam's sin of disobedience is near at hand, and that the reign of perfect love, justice, purity, and holiness is soon to commence. They observe the Sabbath of the Hebrews as a holy day of rest and assemble weekly for worship on the evening (Friday) before the Sabbath.

Restoration, in matters of fine art, the putting of a building, a work of sculpture, a painting or other work of art into what is thought to have been its original perfect condition. There is, however, a secondary meaning which is often used in a way to cause confusion: this is the preparation of drawings showing what, in the opinion of the draughtsman or his director, would be the appearance of the building or other work of art if restored according to the above definition. The term «conjectural restoration» is applied to these drawings, though all restoration is more or less conjectural, but the adjective is used in these cases because the drawings often represent much more complete and precise, and much less thoroughly verified statements concerning the original state of the work of art than those which are actually carried out.

To treat first of these suggestions for restoration embodied in drawings: Among the most useful in the way of architecture are some by Sibil, who continued the work of Letarouilly in his folio work on the Vatican in Rome, and those by the well-known author and architect, Viollet-le-Duc, especially in the plates to 'Entretiens sur l'Architecture,' and in three or four large lithographs for display on the walls of schools and the like. These are based upon a very exact knowledge of the processes of building. There are some of singular interest in the work on the discoveries at Pergamon, by Pontremoli and Collignon ('Pergame,' Paris, 1900); in the kindred work on 'Epidauros' by Defrasse and Lechat, Paris, 1895; also in a three-volume book called 'La Restauration d'Olympie' by Laloux and Monceaux. In such drawings a building will be shown complete and in use, with figures near it and passing up and down its flights of steps, or seated on its stone benches. Life is given to the representation by landscapes fitted to the purpose, or by other carefully considered surroundings. In connection with these there should be mentioned also the models in plaster, the preparation of which is a serious art in Paris and in other great centres of artistic study. These models, when concerned with a non-existent building, may be a complete rendering of that building, as in the case of the model of the Parthenon and that of the Hypostyle Hall at Karnak, both at the Metropolitan Museum of Art, New York. In these there has been a bold attempt to show, as if definitely known, the entirely uncertain structure of the roof of the great temple, and also the painting on the same building, according to the theory of the accomplished architect who designed the model, the late Charles Chipiez: but the Egyptian temple has its paintings modified on account of modern notions of propriety. The model of the Pantheon at Rome, in the same collection, can be visited both within and without, and is more nearly trustworthy than that of the Parthenon. All of this, however, is conjectural restoration of excellent quality.

Restoration of buildings, when carried out in reality, is extremely open to error of the most mischievous sort, because it is never safe to assume that the last word has been spoken in the matter of demonstration of the building's original condition. We, in 1904, cannot for a moment accept the archæological knowledge of our predecessors of 1860, and yet in the years following the middle of the 19th century nearly all the most important mediæval buildings of Europe were restored, and too often in a radical way. In too many cases the original character of the building is destroyed altogether, as in the famous instance of the Church of Saint Front at Périgueux, and in the case of the Fondaco dei Turchi at Venice, now the Museo Civico; but in a vastly greater number of cases the restoration has been conscientious and in a way judicious, but has still destroyed much that would be, had it been spared, the best possible evidence for the original study of the structure. It will be noted that the ambition of the official or committee in charge of a great building, religious or secular, is nearly always to have it as complete and elegant as may be; that this ambition is more than repeated in the architect whose reputation and pecuniary gain are closely connected with the great and costly undertaking; and finally that these ambitions find an echo in the opinions of the general public, who, of course, like to see the famous monument of their city put into first-rate order and kept as clean and perfect and bright-colored as the new buildings near. To this is added the actual demand for safety. Thus, in the case of the Ducal Palace at Venice, of which the restorations were carried on between 1881 and 1884, a conscientious desire to preserve the famous building intact was present in the mind of the controlling intelligence: but the great capitals of the lowermost arcade upon which the whole weight of wall reposes were in many cases found to be so split that they were unsafe. It may well have been thought with perfect honesty that the preservation of the building required their removal; they were removed and placed with all care in a hall of the building, while newly cut capitals were put in their place. St. Mark's was more hardly treated, for the exquisite marbles with which the exterior was sheathed were carried off and replaced by slabs of a vastly inferior quality and color, a certain smoothness and a certain appearance of finish being thus got at the expense of the chromatic beauty of the original work. Nothing need be said of the mosaics, because they are always in a state of change, repairs and restorations going on all the time: but the change in the great floor of the church by which the singular waves and hollows which had marked it for so many years were all graded and the floor smoothed out into a glossy, modern pavement, excited at the time the greatest indignation on the part of many, and can hardly be satisfactorily criticized; there being so much doubt as to the true cause of the old inequalities.

There is still another difficulty in the restoration of buildings, namely, the introduction of later, though still early, details. Thus in a Gothic cathedral, especially in England, one whole bay of the north or south aisle will have been built up with 14th century windows, contrasting oddly with the "early English" fenestration of the neighboring bays. Shall the restorer respect these changes of an earlier time, or shall he sweep them all away and make the church that which, according to his best lights, it was in (say) 1195? It is evident that there is great room for disagreement as to this, and that no restoration of such building can ever satisfy the student altogether. It is evident that every precaution should be taken to save the old work and that the interests of fine art and archæology alike demand the preservation of every bit and scrap of building as it has reached us from antiquity, repairs being carried out only in so far as to save the ancient pile with all its details. At the same time excuses can readily be found for those who advocate a sweeping restoration: for, as they would say, the building was meant to be used and was meant to have a certain general aspect: is it not probable that we know enough to put it back to its original character? Unbelieving critics can never persuade these people of their own probable ignorance.

In sculpture the case is more simple. Until within the last 25 years an important antique statue was generally restored, and the most skilfully carried out restoration was perhaps that of the Ægina sculptures in the Glyptothek in Munich. These are said to have been directed by the celebrated sculptor, Bertel Thorwaldsen, and they have a wonderful appearance of verity, while at the same time no one can say how far the surface of the marbles found in Ægina have been lowered in places to agree with the restoration. It has always been considered a wonderful piece of good fortune at a time too early for such intelligence in archæological matters — the preservation from restorations of the Venus of Milo in the Louvre, this preservation having been largely the result of disagreement. On the other hand, the finds of the years since 1870 are much more commonly preserved intact; no one will think of restoring the Hermes of Olympia. Even in our own time, however, such slight injuries as the breaking of two or three fingers in the Augustus of Otricoli in the Vatican, or in the Venus of the Capitol, are pretty certain to be repaired, but then it is the custom of all properly managed museums that a label shall hang on the pedestal with a full description of the additions made, and the catalogues of the better organized museums contain also such a mention in full.

In the matter of painting it has long been understood that there is only one safe way, and that is to refrain from bringing a brushful of paint anywhere near the canvas. The old picture has suffered certain injuries; it must not therefore be subjected to the greater injury of falsification. As late as 1885 paintings in several of the museums of Europe were undergoing repainting of the most radical sort. Any person who was looking into the matter at that time would miss from its place in a church or gallery some great canvas. If he were shrewd and bold he would get sight of that canvas set up against a wall on its side, or on its head perhaps, and there undergoing a process of repainting in sky or drapery at the hands of the most unintelligent operative who could use a palette and a painter's pencil. By and by the picture would be in its old place again, and then the few who look closely into a picture would feel that their old friend and inspirer was gone. The director of just such a restoration said to the writer that he was quite aware of the opinion of the foreign visitors that this ought not to be done — that only a patch of neutral color should be put in where an actual blister had existed — where color had left the canvas altogether — that, in short, the picture should be mended, but not repaired and renewed with an attempt to imitate its original surface. He was a good-tempered old gentleman, and made no pretense at artistic pride in his work, which indeed was going on at the hands of the most forlorn and careless copyists, but it was his work, for which his salary was paid. It was suggested long ago that every picture in a public gallery should have hung on its frame an exact account of what had been done to it and when — whether partial repainting or repairing of positive injuries, revarnishing, transferring from wood to canvas, or the like. This, however, has not been done as yet, and the student of the most precious paintings in the world is grievously handicapped by the primary difficulty of discovering what is really the artist's work and what is the ignorant tinkering of irresponsible moderns. RUSSELL STURGIS.

Restoration, The, in English history a term applied to the accession of King Charles II., in 1660, after the civil war, to the throne of England, after an interregnum of 11 years and four months, from 30 Jan. 1649 (when Charles I. was beheaded) to 29 May 1660. In

French history, the first restoration begins 3 May 1814, when Louis XVIII. made his entry into Paris under the protection of foreign bayonets, and ended with the return of Napoleon from Elba, 20 March 1815. The beginning of the second restoration is generally reckoned from the battle of Waterloo, 18 June 1815; and terminated on 29 July 1830, with the abdication of Charles X.

Restora'tionists, the followers of Origen in the opinion that after a certain purgation proportionate to their delinquencies all will be restored to God's favor and to paradise. In the Middle Ages, the Brethren of the Free Spirit held this doctrine; at the time of the Reformation, it was taught by the Anabaptists and in the 18th century by the Rationalists. See also UNIVERSALISM.

Resumption, the return to specie payment by a government. The Resumption Act of 14 Jan. 1875 fixed 1 Jan. 1879 as the day on which specie payments should be resumed by the United States government. Resumption actually took place on 17 Dec. 1878, when the premium on gold disappeared.

Resurrection, an article of belief contained in all the formularies of the Christian faith, namely, that at the last day all the human creatures that shall have lived on earth will rise from their graves in the bodies which they had in life. It is a doctrine peculiar to the Christian religion, one not entertained by the pagan nations of antiquity nor by the Hebrews till the latter period of their history as a nation. In the Hebrew scriptures are many passages which favor more or less the doctrine of the resurrection of the dead; but such passages are in no instance free from ambiguity; and even were it to be granted that they unequivocally assert a resurrection, they do not accord with the doctrine that is taught in all the creeds of Christendom, namely, that when the period of man's life upon the earth is closed then the entire human race, not the good alone, but the wicked, not the blest alone, but those also who are destined to everlasting punishment shall arise from the grave with the bodies which they had in life and appear before the supreme tribunal. The passages of Hebrew Scripture that have been regarded as intimating this doctrine are chiefly Isaiah xxvi. 19, Job xix. 23-27, and Daniel xii. 2. The passage of Isaiah, as rendered in the Authorized Version is, "Thy dead *men* shall live; *together with* my dead body they shall arise." The words italicized are supplied by the translators. In the Septuagint the latter half of the passage is rendered, "and those in the graves shall arise." If this is unequivocally a declaration of the resurrection of the bodies of men, at least it does not assert that there will be such a resurrection of the entire human race. Job xix. 25-27 reads: "I know that my redeemer liveth and that he shall stand at the latter *day* upon the earth; and *though* after my skin *worms* destroy this *body*, yet in my flesh shall I see God: whom I shall see for myself, and mine eyes shall behold, and not another." Again a mutilated Hebrew text, with variant readings and variously translated in the versions: but granted that it tells of a resurrection on the last day, it says at most only that Job will then appear in his body as when he lived — one man, not all mankind. Much clearer and stronger is the passage, Daniel xii. 2, "Many of them that sleep in the dust of the earth shall awake, some to everlasting life, and some to shame and everlasting contempt": this is explicit, but it does not say that *all* the dead will arise clothed in their bodies; and this becoming "awake" does not necessarily imply re-assumption of the bodies at all. Toward the time of the downfall of the Jewish nation the belief in the resurrection of the body was generally entertained among the Jews: in the apocryphal book 2 Maccabees the doctrine of the resurrection is strongly asserted, yet even there nothing is said about a resurrection of all the dead; and though the resurrection of all the dead is now the 13th article of the Jewish creed, it is a doctrine that cannot be proved from the Talmud or the Midrashim, according to which only the just will rise again. But in the books of the New Testament the resurrection of all on the last day is explicitly declared, and in all the formularies of Christian belief, beginning with the Apostles' Creed, this doctrine is most distinctly asserted. That not only the just but also the wicked shall rise again is explicitly taught by the Founder of Christianity in Matt. v. 29, x. 28, and particularly in John v. 28, 29, "The hour is coming in which all that are in the graves shall hear his voice, and shall come forth; they that have done good, unto the resurrection of life; and they that have done evil, unto the resurrection of damnation." — THE RESURRECTION OF JESUS CHRIST on the third day after his crucifixion is by Saint Paul made the very basis of Christian faith: "If Christ be not risen then is our preaching vain, and your faith is also vain." The evidence of the truth of Christ's resurrection, for those who were to form the first nucleus of his church was the fact that on eleven different occasions between the resurrection and the ascension into heaven he manifested himself to his apostles and others, his companions and friends: and these testify to the truth of this resurrection in clear, definite, positive statements. Those who deny the objective reality of Christ's resurrection — and it was denied in the very first age of the Church — attempt to explain it away on various grounds; but his disciples distinctly testified that it was Jesus himself, in corporeal presence, who conversed with them at sundry times during the 40 days preceding the ascension.

Resurrection, a novel by Leon Tolstoy, published in 1900. It presents in the author's strongest manner the theme of the development of a great character, besides offering a picture of Russian society, from the wealthy office-holding circle, to the peasants and common soldiers, jailers, and criminal classes. Nekhludoff, a noble, in the effort to right the wrong he has done to another, unconsciously rights the wrong done in himself by the false social outlook and inadequate education which had made him what he was, and constructs for himself a new and broadly human creed of living.

Resurrection Fern. See FERNS AND FERN-ALLIES.

Resurrection Plant. See ROSE OF JERICHO.

Resurrection Sisters. See ORDERS, RELIGIOUS.

Resurrectionists, or **Body-snatchers,** a class of miscreants who, in Britain previous to the passing of the Anatomy Act of 1832, made a livelihood by rifling graves, taking out the corpses and selling them to schools of medicine and surgery as «subjects» for dissection or demonstration. So long as in Britain the supply of «subjects» from the gallows sufficed for the needs of the schools, there was no call for a resort to illegal means. But when, in the progressive reform of criminal law, capital punishment was less frequently inflicted, while medical and surgical schools were greatly multiplied, the necessity for «subjects» overrode the laws, and the trade of the resurrectionist flourished. As the schools were mostly in London, the graveyards in the vicinity of the metropolis were the main resource of the body-snatchers, with whom the grave-diggers and the caretakers were usually in league. As the business was naturally risky and precarious the price of «subjects» was, for each, $40 to $50. To protect the bodies of the newly interred, their graves would be protected with strong gratings, or spring-guns would be set at night, or the friends of the deceased would keep watch, armed, over the graves for several nights till the bodies had become unfit for use in the schools. These precautions made the business of the body-snatchers even more risky, and «subjects» would be sought in various localities throughout the kingdom. As the price paid by the doctors rose and the risk grew greater, it occurred to one Burke at Edinburgh to provide subjects for the dissecting table by killing people instead of violating graves. He was hanged at Edinburgh 28 Jan. 1829, convicted of having despatched 15 victims and sold their bodies to the doctors. The first Anatomy Act of the British Parliament (1832) provides that schools of anatomy and teachers and demonstrators of anatomy shall be licensed; such schools and such teachers are empowered to receive as subjects for dissection the cadavers of persons dying friendless, in poorhouses, hospitals, and elsewhere; and the trade of the resurrectionist was practically done away in Britain by the passage of the act. In the United States there are not in any of the individual States any statutes regulating the practice of anatomical dissection: the plundering of graves for subjects of dissection is a misdemeanor for which the offender may be indicted at common law. Instances are not very rare of the bodies of persons, not friendless, who die in public or quasi-public hospitals, being, without legal warrant, sold to the schools by subordinate employees of such hospitals. Body-snatching, or rifling of graves for the purpose of exacting a ransom from the families of the dead is not infrequent: a notable instance was that of the stealing of the body of the late A. T. Stewart in 1878. The body-snatchers in this case demanded a ransom of $200,000, which afterward they reduced to half that sum: finally, they received $20,000 with the assurance that they should not be prosecuted: since that time extraordinary precautions are taken against body-snatching from the graves, especially of very rich persons.

Reszke, rĕsh'kĕ, **Edouard de,** Polish opera singer: b. Warsaw 23 Dec. 1856. He studied at the Collège de l'Agriculture of Proskao, and then turned attention to the cultivation of his remarkable bass voice. He appeared in Paris in 1876 at the Théâtre Italien, and since then has sung in the large cities of Europe and America. He created the role of the King in Catalini's ‘Edda’ and Carlo V. in Marchetti's ‘Don Giovanni d'Austria’ at Turin. He is especially identified with Mephistopheles in ‘Faust’; Frère Laurent in ‘Romeo et Juliette,’ and the Wagnerian roles of Hans Sachs, Wotan and King Mark.

Reszke, Jean de, Polish opera singer: brother of Edouard de Reszke (q.v.): b. Warsaw 14 Jan. 1853. He completed the law course at the Warsaw University; but having been surrounded by a musical atmosphere in his home, and having sung as a boy in the cathedral, he decided upon singing as a career. He studied with Ciaffei and Cologni in Italy and made his début in Venice in 1874 as Alfonso in ‘La Favorita.’ In the two following years he appeared in London and Paris. Hitherto he had sung baritone roles, but in 1876 he retired to cultivate his natural voice whose register was that of a tenor. In 1880 he reappeared, singing at Madrid in ‘Robert le Diable.’ Following this he created the part of Jean in Massenet's ‘Herodiade’ in Paris and was engaged at the Opera where he sang from 1885 to 1890, appearing in ‘Le Prophète,’ ‘L'Africaine,’ ‘Aida,’ ‘Faust,’ ‘Romeo et Juliette,’ ‘Don Juan,’ and ‘Le Cid’ which Massenet composed for him. From 1893 to 1899 he appeared continuously at the Metropolitan Opera House, New York, where he added to the foregoing roles several Wagnerian parts, particularly ‘Siegfried.’ In recent years he has been associated artistically with his brother Edouard.

Retaining Wall, a wall erected for the purpose of confining a body of water in a reservoir, or for resisting the thrust of the ground behind it. Without such a wall the earth would lie at a considerable angle off the perpendicular. The angle it makes with the horizontal is called the angle of repose, and varies with the nature of the material. The amount of resistance necessary to be afforded by the wall depends partly on the material and partly on the angle of repose. For the pressure against the wall is produced by the material filling the space between the angle of repose and the face of the wall; and the less this angle the greater the quantity of material required to fill the space, and the heavier the material the greater the pressure. It will hence appear that the great condition to be observed in the erection of these walls is that the sum of the forces tending to displace the wall shall be exceeded by the force tending to produce stability. As a general rule the thickness of retaining walls is made one third the height of the bank which they are intended to support. In estimating the requisite thickness of the wall, account must be taken of the different ways in which it may be displaced, as by overturning, slipping along its entire base, or the giving way of the upper parts while the base remains. In reservoir walls of masonry, the thickness should be made practically double that of ordinary earth retaining walls.

Retentiveness, a quality of memory by which the after-effects of mental processes are long held, with capability of reproduction. Retention is of primary importance in judgment, particularly in the study of processes that are continuous, or in which there is a continuity of interest. Thus when one hears a succession of sounds, and judges that the second, for instance, is louder than the first, the property of retention, by which the after-effect of the hearing of the first sound is compared with the second, is of great importance. In many this attribute of retentiveness is weak, seriously impairing their judgment. See JUDGMENT; MEMORY AND ITS DISEASES.

Rethel, rā'tĕl, **Alfred,** German painter: b. Aix-la-Chapelle 15 May 1816; d. Düsseldorf 1 Dec. 1859. He studied at the Academy of Düsseldorf (under W. Schadow) and afterward at Frankfort (under Philip Veit and Schwind). Here he painted ‘The Resurrection of Christ’ (in the Church of Saint Nicholas), ‘Daniel’ (in the city museum), and ‘Justice Pursuing a Fleeing Murderer.’ When there was a competitive exhibition held of designs for frescoes in the town-house of Aix-la-Chapelle representing incidents in the life of Charlemagne, he was chosen to do the work, and lived to complete four of them; the other four being executed from his designs after his death. These are considered the finest productions of his brush. He painted in water-color a series of pictures illustrative of ‘Hannibal's Passage of the Alps,’ which were afterward reproduced by wood engraving. In 1848 he executed his ‘Dance of Death’; and drew a number of designs on wood. His style was notable for grandeur and energy, and his frescoes are among the finest modern examples of that style in Europe. In 1852 he was seized with a nervous affection for which he sought relief by traveling, but died insane.

Retiarius, rē-shĭ-ā'rĭ-ŭs, a netman, that is, a Roman gladiator who wore only a short tunic and carried a trident and net, with which he endeavored to entangle and dispatch his adversary, who was armed with helmet, shield, and sword.

Retina. See EYE.

Retreat, Spiritual, or **Retreat,** in devotional language, a season of retirement from ordinary secular occupations and of prayer, of meditation upon the truths of religion and the duties of the Christian life, of examination of conscience, of serious consideration of one's spiritual state, etc. The Retreat is also called the Spiritual Exercises, that being the name given to it by Saint Ignatius de Loyola, whose plan of the Exercises (*Exercitia spiritualia*) has ever since his day been the directory of the Spiritual Retreat. The Exercises are arranged for a retreat of 4 weeks, but usually the time is abridged to 10 days or a week. See EXERCISES, SPIRITUAL.

In military language, a retrograde movement, whether forced or strategical, by which troops retire before an enemy: it differs from a flight in being orderly and under control. An army in retreat must be covered by a powerful rear-guard, which from time to time must, if the enemy is pursuing, hold the pursuers at bay, while the artillery and the baggage pass defiles, cross streams or overcome any obstacles.

Retribu'tion, in anthropology and in law: in anthropology the retribution theory expresses the belief in states of happiness or of misery in another world, allotted to men according to their deserts while living on earth. Tylor (‘Primitive Culture,’ ch. xiii.) does not find this idea existing universally in the religions of the lower range of culture that have not been affected by contact with higher religions. The most primitive view of the life beyond the grave was, he holds, that it is simply a continuation of the present: to this succeeds the belief that excellence valor, social rank, etc., modify circumstances and surroundings in the next life; out of this, he believes, was finally developed a doctrine of future rewards and punishments.— In law, the theory of retribution, or retributive theory is, that punishment is inflicted in retribution for an offense, and ought to be similar the misdeed: this is the principle of the retribution prescribed in the Hebrew law — «an eye for an eye, and a tooth for a tooth.» In modern legislation deterrence displaces retribution: it is held that no more punishment should be inflicted than suffices to deter others from committing the offense: even the death penalty is not defended on the principle of «Life shall go for life,» but because with abandoned criminals capital punishment has a more deterrent effect than has life imprisonment.

Retriever, a dog, trained to find out and bring back any killed or wounded game. The two varieties of British retriever differ only in coat. The larger and more familiar breed of retrievers, the wavy-coated, is formed by crossing the Newfoundland and the setter; the smaller or curly-coated breed is formed by crossing the water-spaniel and the terrier. The typical retriever is 20 or more inches high, with a stoutly-built body, strong limbs, webbed toes, and black and curly fur. See DOG.

Returning Boards. All State governments have provision for the final canvass of votes in State elections by some central authority, known as a returning board, or by some similar designation. The duties of these boards are ministerial, and they have no right to go outside the face of the returns. In the Presidential election of 1876 the returning boards of Florida, South Carolina and Louisiana, controlled by the «carpetbag» and negro element, went behind the returns, and assumed to cast out sufficient votes on the ground of alleged fraud and intimidation to give those States to the Republican electors. A great ferment resulted, and in order to allay the agitation and arrive at a correct conclusion, an electoral commission was appointed, which decided in favor of the Republican candidate, Rutherford B. Hayes.

Retz, rĕtz, **Rais,** rāz, or **Rays,** rāz, **Gilles de Laval de,** French military officer: b. 1404; d. 26 Oct. 1440. He was a Breton of high rank, and distinguished himself under Charles VII. in the struggle with the English, fighting by the side of the Maid of Orleans. Subsequently he received the baton of marshal. He retired to his estates, but was brought to trial by the Bishop of Nantes, charged with sorcery and the practice of cruelty in the celebration of demoniac rites. He was convicted and burned. Attempts were once made to find in Retz a historical original of Bluebeard, but, of course, in vain.

Retz, Jean François Paul de Gondi, CARDINAL DE, French politician: b. Montmirail 19 Sept. 1613; d. Paris 24 Aug. 1679. His instructor was the celebrated Vincent de Paul. In 1643 he received a doctorate at the Sorbonne, and was appointed coadjutor of the archbishop of Paris. Although preferring military service he found he could gratify his ambitions in the church and his impassioned eloquence won him the favor of the Parisians. Aiming at political influence he incurred the enmity of Richelieu, and, after his death, of Mazarin. The Fronde, or the party opposed to the court and Mazarin, received the coadjutor as a man whose genius and popularity made him a valuable accession, and De Retz embraced their cause with zeal. The various insurrections of the people and the Frondeurs obliged Mazarin to leave France, whereupon De Retz seemed to have it in his power thenceforth to hold the reins of government. But Mazarin soon returned from his banishment, more powerful than ever. The Fronde, which had never been firmly united, and the members of which, with the exception of Condé and De Retz, were weak and wavering, was dissolved; and soon after the latter, not without the management of his enemy Mazarin, had obtained the cardinal's hat, he was unexpectedly seized and confined in the castle of Vincennes, whence he was subsequently removed to Nantes. Here he found means to escape, and, perpetually pursued by officers of Mazarin, wandered for eight years through Europe.

After the death of Mazarin in 1661 he was allowed to return to France, after having promised never to take part again in political combinations. He now resigned his archbishopric, governed the abbey of St. Denis, lived retired, restricted his wants, paid his immense debts, and distributed pensions to his friends. Reconciled with all parties he lived the retired and quiet life of a philosopher. His posthumous 'Mémoires' (1718) give an interesting picture of his character. The best edition of his works is that in the 'Grands Ecrivains de la France' series (1872-90). An abridged edition was published in 1865 in one volume. Consult: Chantelauze, 'Le Cardinal de Retz, Etude historique' (1878); 'Le Cardinal de Retz et ses Missions diplomatiques à Rome' (1819).

Retzsch, rĕtsh, **Moritz**, German artist: b. Dresden 9 Dec. 1779; d. Holflossnitz, near Dresden, 11 June 1857. As a painter his subjects were taken largely from German and Greek mythology and display beauty in drawing and color. Retzsch's illustrations of the great poets, comprehending the drawings executed by him for editions of Goethe's 'Faust,' and the works of Schiller and Bürger, have rendered him deservedly famous. He executed a 'Shakespeare Gallery' consisting of 80 plates. In 1824 he was appointed a professor in the Art Academy at Dresden. His illustrations of poetry and legend were done in outline and are distinguished by exquisite delicacy and refinement of form and expression.

Reuchlin, roiн'lĭn, **Johann** (Hellenized Kapnio), German Hebrew scholar and humanist: b. Pforzheim, Baden, 22 Feb. 1455; d. Liebenzell 30 June 1522. The excellence of his singing procured him a place in the chapel of the Margrave of Baden, who appointed him traveling companion to his son Frederick, afterward bishop of Utrecht. In 1473 Reuchlin accompanied that prince to Paris, and there studied Greek under Hieronymus of Sparta, besides applying himself assiduously to Latin composition and Hebrew. In 1475 he went to Basel, and after some time spent in the study of Greek began to teach that language, with Latin and philosophy. At this time also he wrote his Latin dictionary, 'Breviloquus, id est Dictionarium singulas Voces Latinas breviter explicans' (1478), the first published in Germany. In 1478 he went back to France, and studied law at Orleans, while he taught, at the same time, the ancient languages. In 1481 he returned to Germany, and taught law and the belles-lettres at Tübingen. Eberhard, count of Würtemberg, soon after took him, as the best Latinist in Germany, in his train on an embassy to Rome. The Emperor Frederick II. created him a noble of the empire in 1492. After Eberhard's death Reuchlin lived several years at the court of Philip, elector of the Palatinate. Here he enriched the Heidelberg library with manuscripts, and productions of the new art of printing. He was subsequently appointed president of the court of the confederacy which had been established by the Swabian princes against the encroachments of the house of Bavaria. He was also engaged in translating the penitential psalms, preparing a Hebrew grammar and dictionary, and correcting the translation of the Bible. A converted Jew, John Pfeffercorn, and Hoogstraten, an inquisitor, obtained from the Emperor Maximilian, in 1509, an order that all Hebrew works, the Old Testament only excepted, should be burned, on the ground that they were full of blasphemies against Christ. The emperor, however, consulted Reuchlin, who assured him that these works, instead of injuring Christianity, contributed, on the contrary, to its honor and glory, since the study of them produced learned and bold champions to fight for the honor of the Christian religion, and that to destroy these books would be to put arms into the hands of its enemies. The order was thereupon recalled, but a war of pens raged for ten years. Passages were extracted from Reuchlin's works and their meaning perverted; on the ground of which a charge of heresy was brought against him. He was summoned in 1513 before the Inquisition at Mainz, presided over by Hoogstraten, and by a decree of that tribunal his writings were consigned to the flames. This roused the indignation of the friends of classical literature, and an appeal was made to Pope Leo X., who referred the whole matter to the Bishop of Spires. That prelate declaring Reuchlin innocent, ordered the monks to pay the expenses of the investigation. A counter appeal was made by Hoogstraten; but Reuchlin was then acquitted by a commission of prelates held at Augsburg in 1516; and the pope issued a mandate that all proceedings against Reuchlin should be stopped. In the course of this contest appeared the 'Epistolæ Obscurorum Virorum,' in which the enemies of Reuchlin were ridiculed. When, in 1517, he received the theses propounded by Luther, he exclaimed, "Thanks be to God, at last they have found a man who will give them so much to do that they will be compelled to let my old age end in peace." In 1518 he was appointed professor of Hebrew and Greek at Wittenberg, but sent his nephew Melanchthon instead, and William of Bavaria appointed him professor in the University of Ingolstadt. Although suspected of a leaning toward Protestantism, he never left the Roman Catholic Church. Consult: Geiger, 'Johann Reuchlin: sein Leben und seine Werke' (1871); Geiger, 'Johann Reuchlins Briefwechsel' (1875); Horawitz, 'Zur Biographie und Korrespondenz J. Reuchlins' (1877); Holstein, 'J. Reuchlins Komödien' (1888).

Reuleaux, rė-lō, **Franz,** German mechanical engineer: b. Eschweiler, Prussia, 30 Sept. 1829. He served an apprenticeship at Koblenz, studied at Karlsruhe and for a year was director of a factory in Cologne. In 1856–64 he taught at Zürich and in 1864–96 was engaged in teaching in Berlin, where he was director of the Industrial School from 1868–96. The German exhibit of machinery at the Philadelphia Exhibition in 1876 greatly impressed Reuleaux with the inferiority of German construction and design and he earnestly strove to remedy the fault. He gathered at Berlin a fine collection of kinematic models and wrote: ‘Der Konstrukteur’ (1860–2); ‘Briefe aus Philadelphia’ (1877); ‘Kurzgefasste Geschichte der Dampfmaschine’ (1891); ‘Thomassche Rechenmaschine’ (1892); etc.

Reuling, roi'lĭng, **George,** American ophthalmologist: b. Romrod, Germany, 11 Nov. 1839. He was educated in Berlin and Vienna, served as surgeon in the Prussian army during the war with Austria, and in 1866–7 was assistant surgeon at the Eye Hospital in Wiesbaden. He studied in Paris in 1867–8, came to Baltimore and in 1869 was appointed physician-in-chief to the Eye and Ear Infirmary there. He was professor of ophthalmology at the University of Baltimore, of eye and ear surgery at Washington University, Baltimore, and since 1886 has been professor of eye and ear diseases at the Baltimore Medical College. He is eye and ear surgeon to various hospitals and institutions, has invented an apparatus for eye and ear surgery and written various articles on the subject.

Reumont, roĭ'mŏnt, **Alfred von,** German historian: b. Aix-la-Chapelle, Prussia, 15 Aug. 1808; d. Burtscheid, near Aix-la-Chapelle, 27 April 1887. He was educated at Bonn and Heidelberg, and in 1835 entered the Prussian diplomatic service. From 1857–60 he was minister resident at Florence, Modena and Parma successively. Besides several valuable biographies, including ‘Michelangelo’ (1834); ‘Andrea del Sarto’ (1835); and ‘Benvenuto Cellini’ (1887); he wrote: ‘Ganganelli, seine Briefe und seine Zeit’ (1847); ‘Geschichte der Stadt Rom’ (1867–70); ‘Charakterbilder aus der neueren Geschichte Italiens’ (1886); etc.

Réunion, Isle de la, ēl dė lă rā-ü-nē-ôṅ, or **Isle of Bourbon,** in the Indian Ocean, about 400 miles east of Madagascar, a French insular colony, with an area of about 965 square miles, its length being 45 miles and breadth 33 miles. It was discovered by Mascarenhas, a Portuguese, in 1545, who called it by his own name. The French took possession in 1649, and gave it the name of Bourbon. It was captured by the British in 1810, and restored to France in 1815. The island is of volcanic origin, composed of two enormous volcanic mountains, in one of which the fire is extinct; the other is still in activity. The loftiest summit, Le Piton de Neige, or the Snowy Pike, is about 10,000 feet above the level of the sea. The climate is excessively hot from November to April; the evenings, however, are refreshed by the sea breezes, and the mornings by the land breezes. The capital is Saint Denis, a pretty town; pop. (1899) 32,850. Other urban centres are Saint Pierre, and Saint Benoît, connected by a railway 83 miles long with the chief port, Pointe-des-Galets. The principal articles of export are coffee, sugar, vanilla, gums, lichens for dyeing, cotton, hides, etc. Sugar is by far the most valuable export; vanilla comes next. Commerce is impeded by the want of good harbors. The population consists of (1901) 173,230 native Africans, Chinese, coolies, Malays, etc., with a French administration and military force of about 1,000.

Réus, rä'oos, Spain, in the province of Tarragona, is an important railway station and a progressive town, with a port at Salou on the Mediterranean, four miles distant. It has excellent schools and model public institutions. Its importance as a commercial centre has increased in a marked manner during the last quarter of a century. Its export houses represent great local industries in the agricultural products of flour, wine, and fruit.

Reusch, roish, **Friedrich,** German sculptor: b. Siegen, Prussian Westphalia, 5 Sept. 1843. He received lessons at the Berlin Academy, and afterward from Albert Wolff. In 1874 he traveled in Italy for purposes of study, and on his return executed some military statues for Siegen and Bensberg, and a group in marble for the Belle Alliance bridge at Berlin. A lucky inspiration was his ‘Demon of Steam.’ This spirited and highly original work was modeled in 1880, and subsequently cast in bronze and set up in the Scientific High School at Charlottenburg. He became teacher in the Art Academy of Königsberg (1881), and meanwhile executed numerous busts and statues for public buildings; the monuments of Vessel, the astronomer, and Jacobson, the oculist; the sepulchral monument of Gen. Bronsart von Schellendorf, and the colossal figure of Emperor Wilhelm I. in his coronation robes which stands in front of the palace (1894). Of his imaginative works the most notable are ‘Psyche Appeasing Cerberus’; ‘Cupid Putting on the Helmet of Mars’; and the ‘Triumph of Cupid over Hercules.’

Reuss, rois, **Eduard Wilhelm Eugen,** German theologian: b. Strasburg, Germany, 18 July 1804; d. there 15 April 1891. He was educated at the University of Strasburg, in Halle and in Paris, was privat-docent at Strasburg and occupied the chair of theology there in 1836–8 and in 1872–88. He was a leader among the liberal Protestant theologians of his day, and an able writer and translator. His works include: ‘History of the Sacred Scriptures of the New Testament’ (1842); ‘History of the Canon of the Sacred Scriptures’ (1862); ‘The Bible, New Translation, with Commentary’ (19 vols., 1877–9); etc.

Reuss, Germany, two central principalities, belonging to an older and a younger line, somewhat intermingled with and lying between Saxony, Bavaria, and the Saxon duchies. Total area of both principalities, 441 square miles, mostly mountainous. The territory of the older line, the principality of Reuss-Greiz, consists of the lordships of Greiz and Burgk, and has an area of 122 square miles. These lordships are separated, one being traversed by the White Elster, while the other lies along both banks of the Saale. The surface is better adapted for pasture than agriculture, rearing great numbers of horned cattle and sheep, but scarcely raising grain sufficient to meet the consumption.

The most important crops are potatoes and flax; hops also are partially grown. The weaving of woolen, linen, and cotton fabrics is also among the principal occupations of the people. The capital is Greiz, and the only other town is Zeulenroda. The territories of the younger line, called the principality of Reuss-Gera-Schleiz-Lobenstein-Ebersdorf, have together an area of 319 square miles. These territories are, on the whole, fertile and well wooded, raise sufficient grain to supply the consumption, and possess among their minerals marble, salt, and iron. The capital is Gera, and other towns are Schleiz, Saalburg, Hirschfeld, and Lobenstein. The division into an older and a younger branch dates from 1616. Since 1668 all the princes of both lines have been called Heinrich (Henry). Both lines, as well as the great majority of their subjects, are Protestants. The principality of Reuss-Greiz has a population of about 70,000; Reuss-Schleiz, of 140,000.

Reuss, Switzerland, a tributary of the Aar, rising on the north face of the Saint Gothard, flowing north past Andermatt and Amsteg, between which places its course is through a wild and narrow gorge, spanned by the Devil's Bridge and other wonders of Swiss roadmaking, and entering the south end of the Lake of Lucerne. This it leaves again at its north end, at the town of Lucerne, and, still going nearly due north, reaches the Aar near Windisch (Aargau). Its length is 90 miles.

Reuter, roi'tĕr, **Fritz**, German dialect poet and story writer: b. Stavenhagen, Mecklenburg-Schwerin, 7 Nov. 1810; d. Eisenach 12 July 1874. He studied law at the universities of Rostock and Jena, and in 1833 was condemned to death at Berlin for his share in a students' democratic society. His sentence was, however, commuted by the king to 30 years' imprisonment. Till 1838 he was a close prisoner in various Prussian fortresses, and after a farther period of confinement in the Mecklenburg fortress of Dömitz was set free in 1840. For 10 years he devoted himself to farming, but in 1850 became a private teacher in the Pomeranian town of Treptow. In 1853 he was made famous by the publication of humorous poems in the Platt-Deutsch dialect, entitled 'Läuschen un Rimels' (new series, 1858). These were followed by 'Polterabendgedichte' (1855) and 'Reis' nah Bellegen' (1855). His later works comprise: 'Kein Hüsung' (1858), a tragical village story in verse; 'Hanne Nüte und de lütte Pudel' (1859); 'Schürr-Murr' (1861), a collection of tales in both Low and High German; and 'Olle Kamellen' (1860–8), his chief prose work, a series of tales in Platt-Deutsch, including 'Ut de Franzosentid' (1860); 'Ut mine Festungstid,' an account of his conviction, and imprisonment (1862); 'Ut mine Strontid,' his masterpiece (1864); 'Dörchlauchting' (1866); and 'De Reis' nah Konstantinopel' (1868); 'Die Drei Langhäuse' (1878), a satirical play; 'Lustspiele und Polterabendgedichte' (1883); and 'Reuter-Reliquien' (1885). Reuter's stories are lacking in plot, but are marked by clever episodes, skilful character drawing, and a humor, which, despite the difficulty of his medium, was universally appreciated in Germany. An addition of his works appeared in 1863–8, and in 1875 two volumes of 'Nachgelassene Schriften,' with biography, were added by Wilbrandt. Consult the 'Briefe an seinen Vater' (ed. Engel, 1896); Lives by Romer (1895); and Wilbrandt (in 'Geisteshelden' 2d ed. 1896).

Reuter, Paul Julius, Baron, German telegraph promoter: b. Cassel, Germany, 21 July 1816; d. Nice, France, 25 Feb. 1899. He settled in Aix-la-Chapelle in 1849, where he first established his system of transmitting news by telegraph to the leading towns on the continent, and in 1858 removed to London, where he undertook to supply the English newspapers with foreign news. His enterprise, known as "Reuter's Agency," occupied a unique field and grew in importance from year to year until it is now in operation in all parts of the world. In 1865 he obtained the permission of the government to lay a cable from England to Cuxhaven, and shortly after to lay one between France and the United States. In 1872 the shah of Persia granted to him the exclusive rights of constructing railways, farming customs, and control of the natural resources of the country, but later exchanged these privileges for that of establishing the bank of Persia. He was created baron by the Duke of Saxe-Coburg-Gotha in 1871.

Reuterdahl, roi'tĕr-dal, **Henry**, American naval artist: b. Malmo, Sweden, 12 Aug. 1871. He received his academic education at Stockholm, Sweden, and after remaining in this country served as newspaper correspondent during the Spanish-American War. He has contributed to various prominent periodicals in this country and England, and illustrated the 'History of the New American Navy' (1903) by John D. Long (q.v.).

Reutlingen, roit'lĭng-ĕn, Germany, in Würtemberg, capital of the circle of the Schwarzwald or Black Forest, on the Echaz, affluent of the Neckar, 20 miles south of Stuttgart. The Church of St. Mary is of great antiquity (13th century), and its tower, 325 feet high, of Gothic type, considered the most beautiful in the kingdom. The environs of the town are most romantic. Its leather and textile industries are important.

Reveillé, rĕ-văl'yĕ, or rĕv-ĕ-lē', the signal given in camp and garrison at break of day, by beat of drum or sound of bugle, for the soldiers to rise and begin the duties of the day.

Revel, rĕv'ĕl, or **Reval**, rĕv'ăl, Russia, capital of Esthonia, on a small bay of the same name, 238 miles southwest of Saint Petersburg. The ancient part of the city on a rocky eminence is surrounded by Gothic walls and contains the cathedral, castle, governor's residence, high school, and aristocratic quarters; other churches, the town-hall, several fine halls, schools, etc., are located in the lower, or commercial, town. There are two harbors: mercantile and naval. Commerce is comparatively unimportant. Flax, linseed, grains, skins, and potato brandy are exported; salt, wine, fruits, and manufactured and colonial goods imported. Pop. about 68,000.

Revelation, in theology, the communication of truth by God to men; also, the truth so conveyed, and especially in the Scripture. There is a revelation of God's will and his purposes made through man's reason and the voice of conscience: Nature everywhere reveals God's attributes — his power, his goodness, his wisdom, his providence; so, too, the history of the tribes of mankind upon the earth affords proofs of divine governance. But the most express revelation of God's purposes toward man is made in the written word, in the record of special divine communications made in time past to holy men "who spake as they were moved by the Holy Spirit"; and this written word is the key to all the other revelations of the divine nature and the divine will. See INSPIRATION; BIBLE.

Revelation, Book of. See APOCALYPSE.

Revelganj, or **Godna,** India, in Bengal, near the confluence of the Ganges with the Ghagra, has an active local trade. It is famous as the home of Gautama, the founder of Buddhism, who also taught here. Pop. 14,750.

Rev'els, Hiram R., American legislator and Methodist clergyman: b. Fayetteville, N. C., 1 Sept. 1822; d. Aberdeen, Miss., 16 Jan. 1901. He was of African descent, was educated at Knox College, Illinois, and ordained to the ministry in 1847. For several years he traveled among the colored people in Ohio, Illinois, Indiana, and Missouri, engaged in preaching and lecturing, and later settled in Baltimore, Ohio, where he acted as a minister and as principal of a high school for colored students. In the Civil War he assisted in the organization of colored regiments and went to the front as chaplain. He settled in Natchez, Miss., after the war, and became an influential citizen. He was a member of the city council of Natchez, elected to the State senate in 1869, and in 1870 was sent to the United States Senate, the first of his race to become a member of that body. He was president of the Alcorn Agricultural and Mechanical University, Rodney, in 1871–83, and at his death was a presiding elder in his church.

Revels, Master of the, an English court officer in former times appointed to superintend the revels or amusements, consisting of dancing, masking, etc., in the courts of princes, the inns of court, and noblemen's houses, during the 12 Christmas holidays.

Revenue, the income of a nation, derived from taxation in various forms. In England the principal source of revenue is the income tax. In the United States the national government derives its revenue chiefly from tariff duties, and internal taxes on alcoholic liquors and tobacco. The revenues of the various States and municipalities are mainly from taxes on land and buildings, and personal property. New York and some other States have an inheritance tax which brings in large returns, so that the New York State government is supported almost without direct taxation. So far as the large majority of citizens are concerned, the forms of taxation in the United States are not directly appreciable. In some countries of Europe revenue is collected by most vexatious methods. In Vienna a small tax is exacted every time the resident of an apartment house goes in or out of the building between 10 P.M. and 6 A.M., the person in charge of the building being the collector, and responsible to the authorities. Methods hardly less annoying are practised in other European cities. The "octroi," a tax on produce of any kind brought into a city from the country districts, is prevalent throughout Europe, and adds to the cost of all kinds of food.

Revenue Cutter, a small armed steam vessel, designed for the prevention of smuggling; so called from the fact that originally the vessel was of the cutter-yacht type. The United State Revenue Cutter Service is a branch of the Treasury Department and its purpose is, principally, to enforce the customs revenue laws. Its immediate supervision resides in a bureau of the department known as the Division of Revenue Cutter Service, which is in charge of a chief and a number of assistants.

Revenue Cutter Service, United States. This service was born in the evening of the 18th century, and therefore on the 4th of August, the current year (1904), it will have been in existence during 114 years of the lifetime of the Republic.

The organization of this service was the conception of our first great secretary of the treasury under the Constitution, Alexander Hamilton, and his recommendations in the premises had the approval of George Washington. In emphasizing its importance Hamilton recommended "giving the officers military or naval rank, which will not only induce fit men to engage, but attach them to their duties with a nicer sense of honor."

The original purpose was to inaugurate a "preventive service," as against illicit trade by sea, and in that sense, to aid the customs service in the collection of the revenue from duties on imposts. The organic act provided for ten small vessels, armed and equipped, and for each a complement of officers and enlisted men. and these formed the nucleus from which has grown the service of to-day.

From the beginning the service was placed upon the same plane as to pay and allowances for its officers and enlisted men, with the officers and soldiers of the army.

Various acts of Congress (1 Oct. 1790, 2 March 1793, 6 March 1796, 1 July 1797) provided for additional and larger vessels, increase of crews, armaments and equipments.

It is interesting to note that this service was the only semblance of a navy possessed by our government from 1790 to 1797, when on 10 July, in the latter year, the first vessel of the then new navy, the 44-gun frigate United States, was launched.

In the meantime the duties of the service were such as were required of an armed service, in guarding the coast and commercial interests, and also against piratical incursions. But during those years our relations with France were becoming strained, culminating finally in active hostilities at sea between vessels of the United States and of France. The difficulties with France, generally known as the "Quasi French war," may be said to have been the first war of the young republic with a foreign power. During its continuance (1798 to 1801) several engagements were fought and many captures were made by our vessels.

The revenue cutter service took an active and brilliant part in co-operation with the navy. Thus, while this service was organized as a preventive service to be operated in the interest of commerce and for the protection of the revenue, it had, in these early years, rapidly developed into an armed and equipped military or naval service, offensive and defensive, and this character has been well and continuously maintained.

At the breaking out of hostilities with France provision for an armed force upon the sea, to convoy merchantmen and to defend the coast, became indispensable. To accomplish these purposes the President was authorized (Act 1 July 1797) to increase the complements of the several revenue cutters, and to employ them in defensive operations on the coast. Under authority of previous enactments the service had been provided with a number of vessels which, for that time, were of considerable size and able sea-going qualities, so that in this year (1798) there were in commission the following named efficient vessels, aggregating 1,140 tons, carrying 96 guns and 416 men:

	Tons	Guns	Seamen and Marines
Brig Pickering	187	14	70
" Eagle	187	14	70
Schooner General Greene	98	10	34
" Scammel	98	10	34
" Governor Jay	187	14	70
" Virginia	187	14	70
" Diligence	98	10	34
" South Carolina	98	10	34

When it was determined, in 1798, to extend hostile operations against France, to the waters of the West Indies, four fleets, under Commodores Barry, Truxton, Tingey, and Decatur, U. S. N., comprising in all some 20 national vessels, were formed to prey upon French commerce and destroy that nation's privateers, the above named vessels of the revenue cutter service were placed in co-operation with the navy, and sailed with the fleets, and in the summer and fall of 1799 did fine service. It was during this war that the frigate Constellation, under Commodore Truxton, captured the French frigates Insurgent, 40 guns, and Vengeance, 44 guns. During the naval operations against France 22 vessels, privateer and other, under the French flag, were captured, and of these 16 were made prizes by the revenue cutters, unaided, while they assisted in the capture of two others.

The Slave Trade.— Under the provisions of law inhibiting the slave trade, between the United States and foreign countries, the revenue cutter service, in common with the navy, took an active part in its suppression, and in the course of its work captured many slavers and liberated an aggregate of 487 negroes.

The War of 1812.— The well-known causes which led up to the War of 1812 between the United States and Great Britain need not be re-told here. But, for the enforcement of the embargo laws of 1807, Congress by the Act of 6 Jan. 1809, and another enactment of the same date, made provision for additions to the fleet of revenue cutters of 42 vessels. Following the proclamation of the President ordering all British armed vessels to leave the ports of the United States, and laying the first embargo in December 1807, to the close of the War of 1812, which ensued, the service bore an honorable and conspicuous part. Numerous and varied duties in the enforcement of the embargo laws up to the date of their repeal, and subsequently the non-intercourse act, fell to the revenue cutter service until the declaration of war, 4 June 1812, when the service entered upon an active career, to capture, burn, sink, and destroy the commerce of the enemy in co-operation with the navy. The first prize in that war was the British trading schooner Patriot, with a valuable cargo, and was captured by the revenue cutter Jefferson, Capt. William Ham, 25 June 1812, just 21 days after the declaration of war.

Following this the cutters Madison and Gallatin made valuable prizes. The British privateer Dart, 14 guns, had been for some time cruising and committing depredations on our coast near Newport, R. I. On 4 Oct. 1813, the revenue cutter Vigilant, Capt. John Cahoon, having augmented his crew by a draft of some 20 men from the United States frigate President, Commodore John Rogers commanding, sailed from Newport in pursuit. Soon after coming up with the enemy he carried him by boarding and conveyed the prize and prisoners to Newport.

One of the most notable actions fought upon the water in the War of 1812 took place in York River, near Chesapeake Bay, on the night of 12 June 1813, between the cutter Surveyor, commanded by Capt. William Travis, and forces from the British man-of-war Narcissus. The Surveyor carried 15 men and was armed with six 12-pounder carronades. The attack was made upon this little vessel by the barges of the British frigate Narcissus, which carried to the conflict 50 men, commanded by Lieut. John Crerie. The enemy was discovered by Travis when within 150 yards of the cutter, but the latter's guns could not be brought to bear, so that the defense was necessarily confined to small arms. To each of the Surveyor's crew was given two muskets, with instructions not to fire until the enemy were within pistol range. The engagement was of brief duration, and the enemy by dint of superior force carried the cutter by boarding, with loss of three killed and seven wounded, while of the crew of the Surveyor five were wounded and the rest made prisoners of war. On the day following this action the British commander returned Capt. Travis' sword with the following letter:

> His Majesty's Ship Narcissus,
> June 13, 1813.
>
> Sir:— Your gallant and desperate attempt to defend your vessel against more than double your number, on the night of the 12th inst., excited such admiration on the part of your opponents as I have seldom witnessed, and induced me to return you the sword you had so nobly used, in testimony of mine. Our poor fellows have severely suffered, occasioned chiefly, if not solely, by the precautions you had taken to prevent surprise; in short, I am at a loss which to admire most, the previous engagement on board the Surveyor, or the determined manner by which her deck was disputed, inch by inch. I am sir, with much respect,
>
> JOHN CRERIE.
>
> Captain S. Travis, U. S. cutter Surveyor.

The lack of space forbids detailed mention of many other incidents to the credit of the service in the War of 1812. But mention is made of the defense of the cutter Eagle in Long Island Sound, pursued by the British frigate Pomone, 44 guns, and gun brig Despatch, 18 guns, and a sloop. The Eagle was commanded by Capt. Frederick Lee, R.C.S. On 14 Oct. 1814 the enemy was discovered. Lee, to escape, ran his vessel ashore near Negro Head, Long Island, stripped it of sails and guns, dragged the latter onto the bluff, and there the enemy was fought from 9 A.M. until late in the afternoon. When Lee had exhausted his shot and fixed ammunition, he tore up his logbook, made cartridges and returned the enemy's fire. Near nightfall the enemy withdrew and the next day Lee succeeded in floating his vessel and was about getting under way when the enemy returned in force, and this time secured the prize. During this engagement the Eagle's colors were shot away three times, and as often replaced by volunteers from her crew.

During this war the revenue cutter service captured 10 merchantmen, 3 barges, 3 officers and 60 men; 1 privateer mounting 14 guns. The cutters Eagle, Mercury, and Active did duty as scouts and on blockade service.

The cutters Commodore Barry, Surveyor and Eagle were captured by the enemy, but after a hard struggle and most gallant defense.

Neutrality Laws.— The enforcement of the neutrality laws, during the European troubles from 1815 to 1823, engaged much of the attention of the service, but this duty has always been a part of the vigilant work of the service, and is no less true of the earlier years than in the operations of later times.

Nullification, 1832.— During the attempt to nullify the laws relating to the collection of revenue from imposts, by the State of South Carolina, five vessels of the revenue cutter service were ordered to Charleston harbor, with instructions «to take possession of any vessel arriving from a foreign port, and defend her against any attempt to dispossess the customs officers of her custody until all the requirements of the law had been complied with.»

The silent influence exerted by the presence of this fleet was a large factor in the solution of the difficulties which menaced peace.

Piracy.— During the early years of the last century, piracy which prevailed along the Gulf coast of our possessions acquired from France and Spain, was suppressed, chiefly by the revenue cutter service. That service waged relentless war upon the corsairs, pursued them into every bay and bayou, broke up their resorts and rendezvous, attacked and dispersed them whenever found. While engaged in this work the cutters Louisiana and Alabama were attacked off the south coast of Florida by the pirate Bravo, commanded by Jean La Farge, a lieutenant of the notorious Jean Lafitte. The Bravo was signally defeated, and carried by boarding in a hand-to-hand struggle. The rendezvous of the pirates on Breton's Island, La., was attacked by the cutters Alabama, Capt. Cartigan, and Louisiana, Capt. Loomis, and the resort broken up. This practically put an end to organized piracy on our Gulf coast, though piratical craft from Mexico, Central America and South America, subsequently made incursions on that coast. The pirate Bolivia with its prizes Antoinette and Isabella were found by the cutter Louisiana, Capt. Jackson, at the South West Pass of the Mississippi River. Jackson attacked at once, captured the Bolivia and liberated the prizes, and carried his prisoners to New Orleans. The Bolivia carried 3 guns and 34 men; the cutter Louisiana 2 guns and 16 men.

Seminole War, 1836–42.— During the Florida war for the suppression of Indian troubles in that region, the revenue cutters Dallas, Washington, Dexter, Jefferson, Jackson, Madison, Campbell and Van Buren rendered valuable and conspicuous service in Florida waters, co-operating principally with the army. Their services were so important and efficient as to induce from the officers under whose direction they operated the following:

> Their prompt and helpful cooperation with the army has called forth the highest commendation from commanding generals, who take occasion to eulogize the services rendered by the cutters.

There were numerous instances of gallant and meritorious services by the officers and men of the revenue cutter service in this war, but the scope of this article forbids more than mention of the fact.

The Mexican War, 1845–7.— The revenue cutter service was represented in this war by the following named cutters: Schooners Forward, Ewing, Van Buren, Wolcott, Woodbury, Morris, and steamers McLane, Legare, Spencer, Bibb and Polk. They took an active part principally in co-operation with the armies under Scott and Taylor.

Some of these vessels, notably the Forward and McLane, served in co-operation with the navy, in the fleet commanded by Commodore Conner. In the squadron of Commodore M. C. Perry, at the capture of Frontera and Tabasco, the Forward took a brilliant part, so much so that the Commodore was moved to say in his official report: «I am gratified to bear witness to the valuable services of the revenue schooner Forward, commanded by Capt. H. B. Nones, and to the skill and gallantry of her officers and men.»

The records of the time are replete with incidents of gallant services by the revenue cutter service in the war with Mexico, but the fact can only be stated here.

Paraguay Expedition.— In the naval expedition to Paraguay, in 1858, the purpose of which is matter of history, the steam revenue cutter Harriet Lane, 7 guns, 8 officers and 104 men, served in co-operation with the navy, and rendered valuable services. In acknowledgment of it the Secretary of the Navy wrote:

> This department in closing its official connection with Captain Faunce (the commander of the Harriet Lane), is happy to express to you its satisfaction at the prompt, energetic and able manner in which he has conducted his command whilst in its service.

Winter Cruising.— The Act of Congress, approved 22 Dec. 1837, now embodied in Section 1536, Revised Statutes, requires that a suitable number of public vessels shall cruise upon the coast in the severe portion of the winter weather to afford aid to distressed navigators. The work outlined in the law has always been effectively performed by the revenue cutter service, and from 1 December to 1 April of every year the patrol of the coast from West Quaddy Head, Maine, to Cape Fear, N. C., is energetically maintained. As a result of the work many hundreds of lives and many million dollars' worth of property have been saved. Vessels of commerce are frequently fallen in with at sea, with sails blown away, crews frost-bitten, and unable to respond to duty; they are taken in tow and to a harbor; others short of provisions and water are supplied, while others again, found stranded, are floated when possible. In short, everything possible is done for the relief and care of the distressed mariner of whatever nationality wherever found, during the hard weather on our storm-driven coast from December to April, and prompt response is always made by the service at the cry of distress at all seasons and all hours.

In the Life-saving Service.— This is an outgrowth of the revenue cutter service, as it formed part of the division of revenue cutter service prior to its organization as a separate service under the act approved 18 June 1878. From its inception in 1848 all stations have been constructed and equipped under the supervision of officers of the revenue cutter service assigned for the purpose. When this service was separated from the revenue cutter service by the act referred to, provision was made for the inspection, drilling, and disciplining of the crews of life-saving stations by officers of the revenue cutter service, and there are at this time (April, 1904) 14 officers of the revenue cutter service on duty in connection with that service. It may fairly be said that the efficiency of the life-saving service in all that relates to its technical features, is due to the energetic and capable officers of the revenue cutter service, who have made the inspections, formulated the drills, practised and drilled the crews of that service. As a matter of course, the able central management of the general superintendent, Summer I. Kimball, is recognized to the full measure.

In the Civil War, 1861–5.— The service was conspicuous and valuable throughout this period. The limits of this article forbid any detail of duty performed during that trying period. It must therefore suffice to say in the main that from the attempted relief of Sumter in April 1861, to the close of hostilities in 1865, the service was at the front.

The Harriet Lane co-operated with the navy at the capture of the fortifications at Hatteras Inlet; the Forward rendered support and assistance to Gen. Butler at Annapolis, Md.; the Miami covered the landing of troops at Lynn Haven Bay for the recapture of Norfolk; the cutter Naugatuck took part in the attack on Sewell's Point, led the naval fleet up the James River and participated in the bombardment of Drewry's Bluff 15 May 1862; the Nemaha rendered efficient aid to the army and navy on the South Atlantic coast, received on board Gen. Sherman at Fort McAllister, Savannah, Georgia, just from his "march to the sea," and conveyed him to the naval fleet below. The Forward, Brown, Agassiz, Toucy, and Antietam rendered important service in the waters of North Carolina, while the Jackson, Hercules, Reliance, Tiger, and Allen performed excellent service in the Chesapeake, co-operating with the naval forces in the gunboat flotilla in those waters.

In Peace from 1867 *to* 1898.— The service is always active, always ready for work. Its achievements have been numerous and varied during times of peace, and honorable, often heroic in both peace and war. It blazed the way to and through Alaska, and for many years from the date of the acquisition of that territory in 1867, except for the occasional visit of a naval vessel, was the only service to exercise authority or to display the national emblem in the waters of that coast from Sitka to Bering Sea, and the Arctic Ocean to Point Barrow. It is on guard in the waters of Alaska from early in May until late in December of every year, rendering aid to shipping, caring for the shipwrecked, and assisting to their homes the unfortunate and the destitute. Its surgeons yearly prescribe for and as far as possible aid the sick, and hardly a year goes by in which more than a thousand cases are not treated or relieved by the medical officers of our cutters in Alaskan waters. In these waters alone the service has rescued and brought home from the Arctic Circle hundreds of shipwrecked whalers, and others, who, but for the timely aid of the service, must have perished.

The memorable cruise of the cutter Bear in the winter of 1897–8, for the relief of whalers in the Arctic Ocean, was performed by officers of the revenue cutter service. The overland expedition from that ship, composed of Lieut. D. H. Jarvis, Lieut. E. P. Bertholf and Surgeon Samuel J. Call, was landed on Nunivak Island, in Bering Sea, in the dead of an Arctic winter, and from that point commenced a wearying march through the snow-covered, ice-bound region that lay between them and their destination, nearly 2,000 miles. Starting on 17 Dec. 1897 they reached their destination on 29 March 1898, taking with them a herd of reindeer as food for the crews of whalers congregated there, and the cheering news that the Bear would arrive with an abundance of food and clothing and to rescue those left and take them to civilization.

On the arrival at Point Barrow Jarvis and his party found terrible conditions confronting, but they set to work with the indomitable energy characteristic of the men, brought order out of chaos, and when the Bear arrived on 29 July following, 97 men were taken on board and conveyed to San Francisco. Of the officers and men who composed the Bear expedition, every one was a volunteer, from the commanding officer, Capt. Francis Tuttle, R.C.S., down.

In the Spanish-American War, 1898.— From the manifold duties in time of peace, the service enters always upon the war stage when duty calls. So in this case, as in all other wars of the nation. Hardly had the tocsin sounded when the revenue steamer McCulloch, bound for San Francisco, was overhauled at Singapore, by cable, directing her to report at Hong Kong to Commodore Dewey, commanding the Asiatic fleet. The ship made a quick run to Hong Kong, joined Dewey, and accompanied him in his Manila campaign, performed fine service, and brought to a waiting world the first news wired from Hong Kong of the victory of Manila Bay. That ship, the McCulloch, remained with Dewey until November following.

In reporting to the Secretary of the Navy, Dewey addressed the following letters:

United States Naval Force on Asiatic Station,
Flagship Olympia,
Cavite, Philippine Islands, June 12, 1898.
The Secretary of the Navy, Washington, D. C.
Sir:

1. I take pleasure in bringing to the attention of the Department the zeal and efficiency of Capt. Daniel B. Hodgsdon, R.C.S., commanding the McCulloch, while serving in the squadron under my command.

2. The McCulloch steamed from Hong Kong to Manila Bay in the squadron formation and ran the batteries at the entrance with the squadron, and while not placed in the line of battle at the battle of Manila Bay,

was kept near by and in readiness to assist any vessel that might be disabled.

3. Since joining my command and up to the time of his detachment Captain Hodgsdon has kept the McCulloch in a high state of efficiency and ready to move at a moment's notice and made her a valuable auxiliary to the squadron.

4. I request that the Department will communicate this report to the honorable Secretary of the Treasury.

I have the honor to be, very respectfully,

GEORGE DEWEY,
Rear-Admiral, United States Navy,
Commanding United States Naval Force on Asiatic Station.

And again, upon the occasion of the detachment of the McCulloch from his command, as follows:

United States Naval Force on Asiatic Station,
Flagship Olympia,
Cavite, Philippine Islands, Nov. 11, 1898.

The Secretary of the Navy:

Sir:

1. On the occasion of the U. S. revenue cutter McCulloch being detached from my command, I have again the honor to request that you will convey to the Treasury Department my appreciation of her valuable services while attached to the squadron under my command.

2. I have already had the pleasure of bringing this to the attention of the Department, at the time Captain Hodgsdon was detached, and now beg to state that all duty assigned to the McCulloch while under Captain Hooper was performed with the greatest zeal, efficiency, and judgment.

I have the honor to be, very respectfully,

GEORGE DEWEY,
Rear-Admiral, United States Navy,
Commanding United States Naval Force on Asiatic Station.

At the battle of Cardenas, 11 May, the revenue cutter Hudson, Lieut. Frank H. Newcomb, R.C.S., commanding, sustained the fight against the gunboats and shore batteries of the enemy, side by side with the naval torpedo-boat Winslow, and when Ensign Bagley and half the crew of the latter-named vessel had been killed and her commander wounded, rescued from certain destruction the vessel and the balance of the crew, under the furious fire of the enemy's guns. This gallant action was recognized by the honorable Secretary of the Navy as follows:

Navy Department,
Washington, D. C., June 15, 1898.

The Secretary of the Treasury.

Sir:— I have the honor to acknowledge the receipt of your letter of the 9th instant, and to forward herewith a copy of the report requested. I regret that inadvertently a copy of this letter was not forwarded to you immediately after it was received.

The rescue of the Winslow by the Hudson was so gallantly done, in the face of a most galling fire, that First Lieutenant Frank H. Newcomb, R.C.S., commanding, his officers and men, deserve the warmest commendation. The Winslow was riddled with shell, disabled, helplessly drifting on to the beach into the hands of the enemy, her captain wounded, her only other officer and half of her crew killed, but the Hudson courageously remained by her in the very centre of the hottest fire of the action, although in constant danger of going ashore on account of the shallow water, until finally a line was made fast to the Winslow, and that vessel towed out of range of the enemy's guns.

Very respectfully,

JOHN D. LONG,
Secretary of the Navy.

President McKinley made the work of the McCulloch and Hudson the subject of a special message to Congress, in terms of high commendation and praise, and as a reward of merit in the case of Hodgsdon of the McCulloch (there being no higher grade in the revenue cutter service to which he could be promoted) that he be retired from active service on the full pay of his grade, and in recognition of the heroic gallantry noted in the letter of the Secretary of the Navy, the bestowal of a gold medal of honor upon Lieut. Newcomb, of the Hudson, and silver medals of honor to each of his officers, and bronze medals to each of his crew.

It will be noted that the only gold and silver medals bestowed by Congress for services in this war, were those for officers of the revenue cutter service.

There were in co-operation with the navy during this war, 13 revenue cutters carrying 61 guns, 98 officers and 562 enlisted men. Of these eight cutters (43 guns), 58 officers and 339 men were in Rear-Admiral Sampson's fleet and on the Havana blockade. One cutter, 6 guns, 10 officers and 95 men in Dewey's fleet, and 4 cutters, 12 guns, 30 officers and 128 men co-operated with the navy on the Pacific coast. Three other cutters, with 25 officers and 210 men, were ordered into co-operation, but the war closed before they were equipped or could get to the front.

There were in active co-operation with the army and navy together in all 20 cutters, carrying 71 guns, 131 officers and 725 men.

The services performed by the vessels of the revenue cutter service in co-operation with the navy during this war have been acknowledged in proper terms by the officers commanding the fleets with which they served.

Duties and General Features.— The cutter service, under the provisions of Section 2752, Revised Statutes, is purely a technical service, in that no person not trained in the technical profession of the sea can hold a commission in its ranks, and under regulations prescribed in conformity with the law referred to, all officers are required to pass rigid professional examinations for entrance and promotion.

The commissions of its officers are of the same (life) tenure as those of officers of the army, navy, and marine corps. Officers enter this, as they do the services named, in the lowest grades and work their way, by promotion, through long years of service (after examination, mental and physical) to the highest.

The revenue cutter service has always been, since the foundation of the government, constantly regarded and treated as a part of the military force of the country. Its vessels are armed cruisers, officered by men bearing the commissions (under military titles, captains, lieutenants, chief engineers, etc.) of the President, by and with the advice and consent of the Senate, and manned by duly enlisted men; its officers and men are uniformed in accordance with the regulations prescribed by the department; naval discipline and routine prevail on board of all its ships; the officers and crew are required to be proficient in naval drills, and to possess a practical knowledge of the use of arms. The service is required by law not only to aid in the protection of the revenue, but to enforce nearly every statute affecting the maritime interests of the country. By acts of Congress the service is required to aid in the enforcement of the quarantine laws, and in preventing the violation of the neutrality laws; to suppress mutinies on board merchant vessels, and to use the armament of their ships and the force on board when necessary to compel compliance.

Under the definite provisions of the Act approved 12 April 1902 all officers of this service are invested with military rank, and are placed upon the same level with officers of the army as to pay and allowances, increase of pay for length of service, retirement on account of physical disability, or upon reaching the age of 64 years.

By law (Section 2757, Revised Statutes) the President may, by a simple order, require the service, or any part of it, to co-operate with the navy, when it at once becomes part and parcel of the naval force of the country, and passes from the jurisdiction of the Treasury Department to the control of the Navy Department. The service is, therefore, a part of the regular armed force of the country, identical in character with the naval service, and may at any time, in peace or in war, be made one by executive order.

Organization, Appointments, Promotions.— The number of commissioned officers authorized upon the active list is as follows:

Of the line: 37 captains, 37 first, 37 second and 37 third lieutenants.

Of engineer officers: 1 captain of engineers, who is also the engineer-in-chief, with the rank of captain of the line; 35 chief engineers, with the rank of first lieutenants; 17 first and 18 second assistant engineers, with the rank of second and third lieutenants, respectively, and 1 constructor with the rank of first lieutenant.

There are at this time (April 1904) 45 officers of all grades on the retired list.

Entrance to the service (line) is confined to graduates of the School of Instruction, United States Revenue Cutter Service, to which young men are appointed after physical and mental examinations, as cadets, serving a probationary term of three years. They are, at graduation, commissioned as third lieutenants, and at every promotion thereafter must pass a satisfactory mental and physical examination.

Entrance as engineer officers. The candidate must pass on a high standard, a satisfactory examination, mental and physical, and is then commissioned in the lowest grade, second assistant engineer. Promotions are only gained after rigid examination and record for efficiency.

The enlisted force of the service numbers about 1,500 men.

There are in the fleet 17 cruisers of tonnage from 550 to 1,480 (gross); 9 cruisers, tonnage from 340 to 528; 18 harbor vessels and launches, 2 sea-going tugs and one sailing bark.

Previous to 1889 the chiefs of the service were civilians, and the consulting engineer was employed from the outside. In that year Capt. L. G. Shepard, R.C.S., was assigned as chief, and Chief Engineer J. W. Collins, R.C.S., as engineer-in-chief. Subsequently, by enactment of Congress, the chief of the service must be a captain, while the captain of engineers is assigned as engineer-in-chief. Upon the death of Capt. L. G. Shepard in March 1895 he was succeeded by the writer.

The following table will show the work of nine years in the performance of the ordinary duties of the service:

Vessels seized or reported for violation of law	1,598
Fines and penalties incurred by vessels seized	$10,721,107
Vessels in distress assisted	796
Value of vessels and cargoes	$19,371,505
Persons on board vessels assisted	10,349
Lives actually saved	820
Medical aid rendered to persons	10,207
Vessels boarded and examined	190,360
Miles covered in all of above work	3,234,245

C. F. SHOEMAKER,
Captain, U. S. R. C. S., Chief Revenue Cutter Service.

Revere, rĕ-vēr′, **Joseph Warren,** American military officer: b. Boston, Mass., 17 May 1812; d. Hoboken, N. J., 20 April 1880. He entered the navy as midshipman in 1828, attained the rank of lieutenant in 1841, served in the Mexican War, and in 1850 resigned from the navy. At the outbreak of the Civil War he was appointed colonel of volunteers in the army, and in 1862 was promoted brigadier-general. He commanded a brigade at Fredericksburg and was engaged at Chancellorsville. For his conduct in the latter battle he was censured by his superior officer, tried by court-martial, and dismissed from the service in 1863. The decision was revoked by President Lincoln, and Revere then resigned. He published ‘Keel and Saddle’ (1872).

Revere (French, RIVOIRE), **Paul,** American patriot: b. Boston, Mass., 1 Jan. 1735; d. there 10 May 1818. He was trained as a gold- and silver-smith, and was skilful in the engraving of designs for silver plate. In 1756 he participated in the expedition for the capture of Crown Point, upon his return from which he set up as a goldsmith, and also practised copper-plate engraving. Among his prints were a likeness of Samuel Adams, a portrait of King Philip, a view of Castle William, and the Boston Massacre. He also engraved the plates for the earliest paper currency of Massachusetts. In 1774 he was one of the grand jurors who refused to serve in consequence of the act of parliament making supreme court justices independent of the legislature as regards salary. In the autumn of that year he became one of the «thirty Northend mechanics,» who patrolled the Boston streets to watch the movements of the British forces. On 14 April 1775 this committee of observation noted preparations in barracks and on board ship on the part of the British. On the evening of the 18th it was seen that troops were marching across the common to the inner bay. Revere forthwith had a preconcerted signal set in a Northend church tower — the honor being claimed for Christ Church and for the church in North Square destroyed by the British — crossed the river, mounted a horse on the Charlestown side, and began his famous «midnight ride.» He was none too early, for at 2.30 800 British troops were landed at Lechmere Point and marched on Lexington. Revere became the trusted special messenger of the committee of safety, and after the evacuation of Boston was made successively major and lieutenant-colonel of a regiment of artillery. He took part in the Penobscot expedition in 1779. After the Revolution he resumed as gold- and silver-smith, built a bell- and cannon-foundry, and in 1801 established large copper-rolling works at Canton, Mass. It is said that he was the first in America to smelt copper ore, and to refine and roll copper into sheets and bolts. He was conspicuously associated with benevolent enterprises. Longfellow's poem, 'The Midnight Ride of Paul Revere,' in which, says Winsor, the author has «paid little attention to exactness of fact,» is well known.

Revere, Mass., town in Suffolk County; on the Atlantic coast, and on the Boston & M., the Boston, R. B. and Lynn R.R.'s; five miles northeast of Boston. The place was settled in 1627, and was first named Rumney Marsh. Until 1738 it was a part of Boston. In 1739 it was incorporated as Chelsea, and in 1846 was set off and reincorporated as North Chelsea. In 1871 the name was changed to Revere, in honor of Paul Revere (q.v.). It is a popular residential town and a summer resort. It has a Massachusetts State Bath House, built and maintained by the State; Revere Town Hall, a memorial to Paul Revere; and a Carnegie Library. It has a number of churches and good public schools. The government is by annual town meeting; the administrative officials elected are five, who constitute a board of selectmen. Pop. (1910) 18,219.

Rever'beratory Furnace, a furnace in which the material is heated without coming into contact with the fuel. Between the fireplace and the bed on which the material to be heated lies a low partition wall, called a fire-bridge, is placed. The flame passes over this bridge, and plays down against the bed, being reflected or reverberated (whence the name) by a flat arch which surmounts the whole.

Reverend, a title of respect given to ministers of religion — in the United States to the clergymen of all religious denominations, including the Jewish Church: the titles very reverend, right reverend, and most reverend, are given to deans and vicars-general, bishops, and archbishops, respectively. A like usage prevails in England, but strict churchmen of the Establishment refuse to accord the title reverend to the clergymen of the dissenting churches. The Bishop of Lincoln in 1874 refused to allow this title to be inscribed on the tombstone of a Wesleyan minister, and his action was approved by judgment of the Arches court; but that judgment was reversed on appeal to the privy council, when the title was declared to be simply one of courtesy and not confined to clergymen of the Established Church. In Scotland the principals of the universities, if they be clergymen, and the moderator of the general assembly for the time being, are styled very reverend.

Reveries of a Bachelor, or A Book of the Heart, a collection of meditative papers by Donald Grant Mitchell, originally issued under the pseudonym, «Ik Marvel.» The first 'Reverie' was published in the 'Southern Literary Messenger' in 1849, and reprinted the following year in 'Harper's New Monthly Magazine.' These papers, full of sentiment, enjoyed a wide popularity at the time of their appearance and still find favor with readers.

Reversion, in biology, the reappearance in an animal or plant of characteristics not of its parents, but of more remote ancestors. This frequently occurs in varieties of domesticated animals or of cultivated plants, which have been produced by artificial breeding, and which suddenly develop traits belonging to the wild stock. The more highly bred and artificial the variety of animal or plant, the more liable is it to show this occasional reversion. That the tendency is strong and persistent appears from the fact that if the variety is not kept pure by careful breeding, as when a flower escapes from cultivation or a race of domestic animals runs wild, it soon begins to resume the characteristics of, or «revert toward,» the wild stock from which it sprang. This reappearance of abnormal characters, as of color, markings, etc., is very likely to occur in the progeny resulting from the crossing of dissimilar races or species, which can be explained only on the supposition that such characters belonged to remote ancestors, perhaps thousands of generations removed. This was illustrated very forcibly by the experiments undertaken at Penycuik, in Wales, by Ewart, in the crossing of zebras with mares, the offspring of which exhibited many peculiarities belonging to neither parent. Under this head, also, will fall the strange phenomenon known to breeders as «throwing back,» where a mother animal, which has previously been mated with a sire of another breed or race, will subsequently, when mated with a sire strictly of her own kind, will sometimes produce offspring showing characteristics of the earlier cross. Consult: Darwin, 'Variation of Animals and Plants Under Domestication' (London, 1888); Ewart, 'The Penycuik Experiments' (London, 1899); and the authorities cited under HEREDITY (q.v.).

Reversion, in law, the right to property which remains after some particular estate has ceased which has been granted by the owner. In the United States this is virtually the only meaning of the term in general usage. In England, where the purchase and holding of annuities is common, a reversion means the present right to a payment to be made at some future time, conditional upon certain contingencies, as in the case of an insurance falling to be paid on the attainment of a certain age, or on the death of the assured. The value of a reversion is easily ascertained when the date of its emergence is fixed, and thus a person who has a right to receive a certain sum of money at a given time is enabled to sell this right for its just value.

Reviews. See PERIODICAL LITERATURE.

Réville, rā-vēl, **Albert,** French Protestant theologian: b. Dieppe, France, 4 Nov. 1826. He was educated at Geneva and Strasburg, and was pastor of the Walloon Church at Rotterdam 1851–72. He then removed to Dieppe, where he spent his time in philosophical studies till called in 1880 to the chair of the history of religions in the Collège de France. He was one of the most radical French Protestants of his time, and among his numerous books are: 'Comparative History of Philosophy and Religion' (1859); 'Redemption' (1860); 'Essais de Critique religieuse' (1860); 'Theodore Parker, sa Vie et ses Œuvres' (1865); 'History of the Dogma of the Divinity of Jesus Christ' (1869); 'Introduction to the History of Religions' (1881); 'Histoire des Religions' (1883–9).

Revised Statutes of the United States, a compilation of all the acts of the Congress of the United States: it was first approved by Congress 22 June 1874, thus becoming law: at that time the compilation included all the laws enacted by Congress down to 1 Dec. 1873. The second edition of the Revised Statutes comprised the first edition as amended by the 43d and 44th Congresses: supplements have since been approved and published containing later acts of Congress. The act approving the Revised Statutes makes that compilation the authentic and authoritative expression of the laws, without reference to the original acts: but the originals may be quoted to show the true intent of the lawmakers if there is any ambiguity in the compilation.

Revised Version, a revision of the Authorized Version (or King James' Version) of the Bible. The project of the revision originated in the Convocation of Canterbury, 1870, when two companies of biblical scholars of the Established Church, one to revise the Old Testament, the other the New, were appointed, with power "to invite the co-operation of any eminent for scholarship, to whatever nation or religious body they may belong." Afterward, under a resolution of the Convocation, two companies of American biblical scholars were formed, to act with the English companies. The work of revision, which was commenced 30 June 1870, was completed 20 June 1884; the New Testament was published in England and the United States in May 1881, and the Old Testament in May 1885. Many readings and renderings proposed by the American revisers were not approved by the English companies either for adoption into the text or the margin, but were ordered to be recorded at the end of the New Testament or the Old, respectively. But an edition of the whole Bible having the renderings preferred by the American companies and many other renderings since proposed by American scholars has been published in the United States and is known as the American Revision. See BIBLE.

Revival of Letters, a term used to designate the revival of literature after the apparent death blow which it received when the barbarous nations of the North destroyed the Roman empire. It commenced about the beginning of the 11th century, and became more potent in the 14th, 15th, and subsequent centuries.

Revival of Religion, a season of religious awakening out of spiritual torpor or indifference; usually brought about by the fervid exhortations of men deeply impressed with the feeling that the churches, the pastors, and the people have been slumbering while Satan has been gaining possession of the kingdom of Christ on earth. The term, revival of religion, is a modern one, but the thing it signifies is as old as Christianity, as old as Israelitism or as religion itself. The mission of every one of the Hebrew prophets was for the revival of religion; in the Christian Church, revivals, though not called by that name, occurred at intervals from apostolic times; and every sincere and enthusiastic reformer — Saint Peter Damiani, Saint Francis of Assisi, Saint Dominic, in the Middle Ages; the Jesuits, the Redemptorists, and other missionary orders; these were in their time revivalists in fact, though not in name. The Reformation is regarded by Protestants as a great awakening of the Christian consciousness, and the well-spring of all the efforts that have since been made for the renovation of the spiritual life in the Protestant churches. In England, at the beginning of the 17th century the religion of the Established Church had degenerated into a cold but decent formalism, but a revival of spiritual interest in the common people was brought about through the instrumentality of the Puritans. After the restoration of the monarchy and of the State church there was a period of spiritual sloth and apathy, infidelity, and immorality, till in the 18th century Great Britain was aroused by the fervid preaching of the Wesleys, Whitefield, Rowland Hill, Romaine, Venn, Newton, Cecil, Fletcher, and others, earnest men who were raised up and qualified by the divine spirit for the work which lay before them. (See METHODISTS.) Simultaneously there was a similar great religious movement in the American colonies, especially New England and New York, called at the time the Great Awakening; it seems to have arisen independently of the movement in the parent country; but it was greatly quickened by the missionary labors of John Wesley and George Whitefield during their visits to the colonies. About the same time there was a remarkable revival of religion in various parts of Scotland, especially at Cambuslang and Kilsyth; and out of a similar awakening in Wales arose the Welsh Calvinistic Methodist Church. In 1839 Kilsyth was again the focus of a great revival of religion, which extended to Dundee, Perth, Blairgowrie, Ancrum, Jedburgh, Kelso, and, in the north of Scotland to Ross-shire and Sutherlandshire. In the first half of the 19th century there were many revivals in the United States, notable among which were those under Charles G. Finney (q.v.), who also visited Great Britain and preached to vast crowds in London and other cities; a notable feature of the great revival commenced in 1830 was the camp meetings (q.v.), assemblies of great numbers of people, held in the open air, and addressed by relays of evangelists from morning till night. In 1858 there was a great revival of religion in the United States, which subsequently extended to the British isles and even to the continent of Europe. Its principal centres at first were New York and Philadelphia, whence it spread throughout the States, producing for a time a sort of federation of the evangelical churches for the promotion of the work of spiritual conversion. In nearly every city in the land meetings for prayer were held daily, often in business hours, in churches, in counting houses, in theatres, and other places of public resort; in the one State of New York more than 2,000 cities, towns, or villages had an active part in this revival; throughout the country the interest in the movement was universal; daily reports of the deep religious feeling of the people were received at the principal centres and published in the newspapers. In New York every evangelical church received large accessions to its membership, and a like report was made concerning Boston, Baltimore, Washington, Chicago, Cincinnati, Pittsburg, and other cities. For nearly two years the meetings for prayer and the labors of the evangelists continued almost unflagging, and for many years noon-hour prayer-meetings continued to be held in the business centres of many of the cities. In the summer of 1859 the movement extended to the north of Ireland, where it was not less fruitful of spiritual good than in America; the people flocked to the services in the open-air meetings or assembled in social gatherings for devotional exercises; there was a noticeable diminution of vice and immorality, especially of drunkenness; and judges and magistrates cordially recognized the reality and power of the spiritual work. From Ireland the revival spread to Scotland, and in Glasgow, Edinburgh, Aberdeen, Perth, Dundee, and the other considerable towns, the religious denominations joined in active exertions to bring the neglected poor within the range of evangelistic and educational agencies. It extended to Wales also, where in one year the increase in the membership of the Calvinistic Methodist body alone was 33,724 souls; the gain to the Independent denomination was 30,000, to the Established Church 20,000, and to the Wesleyan body 10,000. Hardly less notable was the revival initiated in Chicago by Dwight Lyman Moody (q.v.) and conducted by him in conjunction with Ira D. Sankey. These two evangelists — a preacher and a singer of the gospel — visited Great Britain in 1873, and for two years in the principal cities of England, Scotland, and Ireland their meetings were attended by multitudes from all ranks of society, and their labors zealously seconded by ministers of all the evangelical churches; thousands of persons professed conversion, and there was a manifest religious awakening. The two evangelists on their return home engaged in revival work of the same kind in the American cities; and they subsequently made two visits to Great Britain, namely, 1883–4 and 1891–2. The Salvation Army (q.v.) and the Volunteers of America (q.v.) are agencies designed to promote a continuous revival of religion, especially among the poor and neglected classes.

Revivals, Religious, seasons at which by extraordinary efforts in preaching, prayer, and hymn-singing, Protestant ministers, especially among the Methodists, seek to arouse the religious feelings and deepen the religious convictions of their hearers. While Protestant revivals were held in England and the United States early in the 18th century, similar movements had taken place previously both in Scotland and Ireland. John Wesley appears to have been the first to develop this method of evangelization into a permanent institution. But in the colony of Massachusetts Jonathan Edwards successfully carried on revivals at Northampton in 1734. George Whitefield was instrumental in extending the movement on his arrival in America (1739), although Gilbert Tennant had previously begun the work in New Jersey. The Great Awakening, as this extended movement was called, occurred between 1740 and 1742, but its quickening results were felt long after and inspired the multiplication of colleges and churches. In the West and South the revival, technically so called, took the form of a camp meeting (q.v.), and these open air gatherings are still made an instrument of evangelization and conversion by the Methodist Church. Out of the camp meeting sprang the Chautauqua Assembly (q.v.), an institution at once educational and religious. Consult: Porter, 'Letters on Religious Revivals' (1850); Starbuck, 'Psychology of Religion' (1900); James, 'Varieties of Religious Experience' (1902).

Revocation of the Edict of Nantes. See Edict of Nantes.

Revolution, a term commonly used to designate a fundamental change in government, or in the political constitution of a country, effected suddenly and violently, and mainly brought about by internal causes; a revolt against the constituted authority successfully and completely accomplished. In the United States the term Revolution is applied specifically to the American War for Independence, which began in 1775 with the irregular running fight popularly known as the battle of Lexington, and practically ended with the surrender of Lord Cornwallis, at Yorktown, Va., to the combined forces of the French and Americans, 19 Oct. 1781. By this war the colonies succeeded in casting off the English authority and in erecting the government of the United States. The English revolution was that revolution in England by which James II. was driven from the throne in 1688. See Rebellion.

In astronomy: (1) The motion of a planet around the sun, or of a satellite around a planet. The point to which it returns is called annual, anomalistic, nodical, sidereal, or tropical, according as it has a relation to the year, the anomaly, the nodes, the stars, or the tropics. (2) In geometry, when one line moves about a straight line, called the axis, in such a manner that every point of the moving line generates a circumference of a circle, whose plane is perpendicular to the axis, that motion is called revolution, and the surface is called the surface of revolution. Every plane through the axis is called a meridian plane, and the section which this plane cuts from the surface is called a meridian curve. Every surface of revolution can be generated by revolving one of its meridian curves about the axis. The revolution of an ellipse round its axis generates an ellipsoid; the revolution of a semicircle round the diameter generates a sphere; such solids are called solids of revolution.

Revolutionary Calendar, a calendar adopted during the French Reign of Terror. It was decreed on 24 Nov. 1793, to commence from the foundation of the French republic, 22 Sept. 1792. The 12 months were Vendémiaire, Brumaire, Frimaire, Nivose, Pluviose, Ventose, Germinal, Floréal, Prairial, Messidor, Fervidor or Thermidor, and Fructidor. The first three constituted autumn, the second three winter, the third spring, and the fourth three summer. Napoleon I. restored the old system, 31 Dec. 1805.

Revolutionary Tribunal. A court of extraordinary criminal jurisdiction established by the French Convention, 10 March 1793, for the purpose of trying those accused of plotting "against the liberty, equality, unity, and indivisibility of the Republic, the internal and external safety of the state, or the sovereignty of the people." It received the name Revolutionary Tribunal in October 1793. The court was to consist of a jury and a public prosecutor with two assistants, all named by the Convention, and from its decision there was no appeal. The number of judges rose as high as 80 toward the end of the tribunal's existence. Intended as a means of combating treason at home, the Revolutionary Tribunal speedily became an instrument in the hands of the Committee of Public Safety, whose will it executed under the guise of judicial form. Without any definite procedure, with no legal defenders allowed to the accused, and with its acceptance of the vaguest rumors and charges as evidence, the tribunal offered but a mockery of justice and citation before it almost invariably meant death. The reading of the act of accusations, the trial, and the execution of the sentence generally occurred on the same day. The tribunal sent 1,220 victims to the guillotine from its inception till June 1794, when Robespierre (q.v.) caused the infamous law to be enacted accelerating its procedure; from that date to the fall of Robespierre, a period of about 50 days, it condemned 1,376 persons, Robespierre and his followers being among the lot. The tribunal soon after ceased its functions and was formally suppressed 31 May 1795. Its sanguinary work must be regarded as justified to a large extent by its success in saving the country from sedition at home at a time of great national danger. It was but one feature of the organized Terror which saved France from foreign conquest. Consult: Wallon, 'Histoire du Tribunal Révolutionnaire de Paris' (1880–2).

Revolutionary War. See UNITED STATES: AMERICAN REVOLUTION.

Revue Des Deux Mondes («Review of the Two Worlds»), a noted French bi-monthly publication, which includes among its contributors the highest authorities in French literature and art, and whose criticisms have weight in every civilized land. It was founded by F. Buloz in 1831, and its present conductor is M. Brunetière.

Rewa, rā'wä, India, (1) the capital of a native state of the same name 131 miles southwest of Allahabad, and connected by a branch line with Sutna on the East India Railway. It is enclosed by three wall circuits or ramparts, the outer one massive, and flanked by round towers. Its chief buildings and institutions are the fortified palace of the maharajah, a high school, hospitals, and a model jail. Pop. 24,000. (2) The native state in the Central India Agency, and in the sub-agency of Baghelkand (q.v.), has an area of 12,676 square miles. It is chiefly an elevated table-land, but also comprises portions of the country on both sides of the Kaimor Hills, watered by the Son, a tributary to the Ganges, and flowing northeast. The surface is in part covered with jungle, but on the whole highly cultivated; the condition of the peasantry is, however, much depressed. The ruins of many temples are scattered over the country. The revenue of the maharajah amounts to about $1,250,000 annually; the armed force consists usually of 4,000 men, though from 10,000 to 12,000 might be mustered. Pop. about 1,700,000.

Rewa Kantha, kän'tŭ or -tạ, India, a political agency under the government of Bombay, containing 61 small states, of which five are tributary to the British government, and most of the remainder to Baroda. The territory included, covering an area of 4,980 square miles, with a pop. (1901) 478,889, lies mainly along the south bank of the lower Nerbudda with patches north of it, and on the western borders of Broach, Baroda, and Ahmadabad.

Reward, in a legal sense, some encouragement which the law holds out for exertions in bringing certain classes of criminals to justice. The courts may order the sheriff of the county, in which certain offenses have been committed, to pay to persons who have been active in securing the apprehension of offenders charged with murder, or with feloniously shooting, cutting, stabbing, wounding, or poisoning, or with rape, burglary, housebreaking, robbery, arson, or cattle stealing or with being accessory before the fact to any of such offenses, or to receiving any stolen property, a reasonable sum to compensate them for expense, exertion, and loss of time. So by a later statute courts are authorized, in the case of any of the above offenses which they have jurisdiction to try, to order such compensation; but the payment to one person must not exceed $25. If any one is killed in endeavoring to apprehend a person charged with one of these offenses, the court may order compensation to be made to the family. The amount to be paid in all such cases is subject to regulations which may be made from time to time by the secretary of state. By another statute it is a felony, punishable by penal servitude to the extent of seven years, to corruptly take any reward for helping a person to property stolen or embezzled, unless all due diligence to bring the offenders to trial has been used. In Great Britain an advertisement offering a reward for the return of stolen or lost property, using words purporting that no questions will be asked or inquiry made after the person producing the property, renders the advertiser, printer, and publisher liable to forfeit $250.

Rewbell, rė-bĕl, **Jean François**, French statesman: b. Colmar 8 Oct. 1747; d. there 23 Nov. 1807. He was a prominent advocate of Colmar, and was elected to the States-General of 1789, where he advocated the principles of the Revolution. He was a member of the Constituent Assembly, where his boldness and legal knowledge made him president in 1791. As a member of the Convention, in 1792 he was outspoken in urging the condemnation of Louis XVI.; but his absence on a mission to the army at Mentz saved him from being numbered among the regicides. He helped suppress the Jacobin Club in 1794, figured as member of the committees of public safety and of general security; and on the adoption of the constitution in 1795 he became one of the five members of the Directory and took in charge the departments of finance, justice, and foreign affairs. In 1796 the Directory elected him its president. He succeeded in defending himself from conviction on charges of peculation, but retired from public life after the *coup d'état* of the 18th Brumaire (9 Nov. 1799) and carried with him a large fortune. Consult Sciout, 'Le Directoire' (1895–7).

Rex'ford, Eben Eugene, American writer: b. Johnsburg, N. Y., 16 July 1848. He was educated at Lawrence University, Appleton, Wis., and began to write for the press at 14. He has published: 'Brother and Lover,' verse (1886); 'Grandmother's Garden,' verse (1887); John Fielding and His Enemy' (1888); 'The Swamp Secret' (1897); 'Flowers: How to Grow Them' (1898); 'Into the Light' (1899); etc. He wrote the popular songs, 'Silver Threads Among the Gold' and 'Only a Pansy Blossom.'

Reyes, Rafael, officially proclaimed as president of Colombia 4 July, and inaugurated 7 Aug. 1904; an explorer, soldier, and statesman. For his discoveries, see South America, sub-title *Railways and Navigation.* Beside the public service rendered by him when he traveled during several years in unknown parts of the Amazon basin, the facts in his career which deserve special notice are the following: He was commander-in-chief of the Colombian army; was sent to Washington, after Colombia had lost Panamá, to «save whatever he could from the wreck»; and in this patriotic effort he was certainly not altogether unsuccessful, since he gained courage to advocate on his return to Bogotá, the policy indicated in the report which he submitted to his government. He advocated, sensibly, courageously, and magnanimously, a frank acknowledgment by his people of their own blundering which had contributed to the disaster; and he continued to show his people how the natural resources of the vast territory still remaining in their possession could be developed by attracting foreign capital. He succeeded. The very great, imperfectly defined powers of the presidency were entrusted to him, despite the old ultra conservatives' hostility to foreign enterprise, and despite the suicidal scheme of the liberals for permitting Colombia to be absorbed by Venezuela and Ecuador. His success saved Colombia from a future of isolation and stagnation, on the one hand, or, on the other hand, nearly complete loss of identity. President Amador of Panamá and President Reyes exchanged congratulatory messages in August, and the American minister was received at Bogotá in December 1904.

Marrion Wilcox.

Reykjavik, rĭk'yä"vĭk. See Reikiavik.

Reynard (rā'nard or rĕn'ard) **the Fox,** the name of an epic fable in which the characters are animals, the fox being the hero, and which in various forms was extremely popular during the Middle Ages, and for many years afterward. The latest version of the story, and that which indeed supplanted all the rest, is in the Low German dialect, and was printed at Lübeck in 1498 under the title of 'Reynke de Vos.' The author calls himself Henrik van Alkmer, schoolmaster and tutor to the Duke of Lorraine, but it is believed that this is merely a pseudonym, and that the real author was Hermann Barkhusen, town-clerk of Rostock, and printer there. The 'Reynke de Vos' is in verse, and founded on the oldest Flemish or Dutch redaction of the story in prose. It relates the adventures of the fox (Reynke) at the court of the king of beasts, the lion, and details with great spirit and humor the cunning modes in which the hero contrives to outwit his enemies, and to gain the favor of his credulous sovereign. The poem may be regarded, with Carlyle, as «a parody of human life.» There is no personal satire in it, but the allusions to the weak points in the social, religious, and political life of the time are numerous and unmistakable. The fables of Æsop are one of the best known examples of the tendency to represent animals as talking and acting like human beings: but it appears that the beast-fable first took on an epic form among the German races, especially the Franks, by whom it was carried to the Low Countries and the adjacent parts of France, where it took firm root. In the 10th and 11th centuries the monks of France gave a satirical and didactic turn to the fable, and some Latin poems in which it is so treated are still extant. In these much of the satire is aimed at the pope, the hierarchy, and the powerful Cistercian order. In the mouth of the Franco-Flemish people, however, the fable kept itself clear of such allusions, and soon took on a more purely epic form, aiming its satire at human failings in general. In 1170 the story in this more purely epic form appeared in Germany under the title of 'Isengrimes Nôt,' and somewhat later again in Flemish. In Germany the beast-fable could not maintain its ground side by side with the Swabian court poetry, and was soon given up; while the rhymed 'Reinaert' of the Low Countries, in accordance with an altered taste, was turned into a prose narrative, 'De Hystorie van Reinaert de Vos' (1479). This was soon after translated into English by Caxton, and printed by him at Westminster in 1481. The fable now returned once more to Germany, where the Low German version of Barkhusen took the place of all others. It was translated (1794) into German hexameters by Goethe, who called it the 'Unheilige Weltbibel,' in his 'Reineke Fuchs.' His translation has been turned into English heroic metre by T. J. Arnold (1870). Consult: Froude, 'Short Studies on Great Subjects' (1877–82); Thom's introduction to the Percy Society's edition of 'The History of Reynard the Fox' (1844); Ellis, 'History of Reynard the Fox' (1894); Jacobs, 'Reynard the Fox' (1895); Martin, 'Le roman de Renarte' (Strasburg-Paris 1882–7); Potvin, 'Le roman du Renard' (Paris 1891).

Reynolds, rĕn'ŏlds, **Edwin,** American inventor: b. Mansfield, Conn., 23 March 1831. After obtaining a public school education he entered a machine shop as apprentice in 1847. He was superintendent of shops at Aurora, Ill., 1857–61, and was general superintendent of the Corliss Steam Engine Company, at Providence, R. I., in 1871–7. Later he became president of the Milwaukee Boiler Company, the Daisy Roller Mills Company, and the German American Bank. He invented the Reynolds-Corliss engine; introduced the first triple-expansion engine, the cross-compound hoisting engines for mining work, etc. Since 1877 he has been general superintendent of the Reliance Works at Milwaukee.

Reynolds, John Fulton, American military officer: b. Lancaster, Pa., 20 Sept. 1820; d. Gettysburg 1 July 1863. He was graduated from West Point in 1841, served in the Mexican War as first lieutenant and in 1855 was promoted captain. He was commandant at West Point in 1859–61 and at the outbreak of the Civil War he was appointed lieutenant-colonel of volunteers, receiving his commission as brigadier-general of volunteers in August of that year. He led a brigade in the Seven Days' battle in June 1862 and was brevetted colonel and brigadier-general in the regular army for gallant service. He was placed in command of the First Army Corps in 1863 and promoted major-general of volunteers. He participated in the battle of Fredericksburg and commanded on the field of Gettysburg on 1 July until killed by a Confederate sharpshooter.

Reynolds, John Hamilton, English poet: b. Shrewsbury, Shropshire, 9 Sept. 1796; d. Node Hill, Isle of Wight, 15 Nov. 1852. He entered an insurance office, but evidently spent much of his time in writing poetry as in 1814 he published two volumes, 'Safie, an Eastern Tale,' and 'The Eden of Imagination,' the first after the style of Byron, and the latter after that of Wordsworth and Hunt. In 1818 he obtained a lucrative post in a solicitor's office, and later was for a time proprietor of the 'Athenæum.' In 1838 he removed to the Isle of Wight, where he became clerk of a county court. Of his numerous poems the best are published in 'The Garden of Florence, and Other Poems' (1821).

Reynolds, Joseph Jones, American military officer: b. Flemingsburg, Ky., 4 Jan. 1822; d. Washington, D. C., 25 Feb. 1899. He was graduated from West Point in 1843 and after service at Fort Monroe and in Texas was, in 1846, assigned to the 3d Artillery and was on frontier duty at Fort Washita, I. T., in 1855-6. He then resigned to become professor of mechanics and engineering at Washington University, Saint Louis. At the beginning of the Civil War he entered the Federal army as colonel of the 10th Indiana Volunteers, soon becoming major-general of volunteers. He was engaged in the battles of Chickamauga and Chattanooga; later was in command of the defenses of New Orleans from 6 January to 16 June 1864; and of the Mississippi River from its mouth to Memphis, Tenn., from October to December 1864. In 1866 he was mustered out of the volunteer service and promoted colonel in the regular army. He was brevetted brigadier-general in 1867, retiring from active service in June 1877.

Reynolds, Joseph Smith, American soldier and lawyer: b. New Lenox, Ill., 3 Dec. 1839. He was graduated at the University of Chicago in 1866, but had previously served through the Civil War in an Illinois regiment, participating in many battles, and being brevetted colonel and brigadier-general in July 1865. After the war he was admitted to the bar, sat in the Illinois legislature 1866-70, was one of the founders of the Chicago park systems, a member of the Chicago Board of Education 1870-4, and State senator 1872-4. He was senior vice-commander-in-chief of the G. A. R. 1875-6; commander of the Illinois Department of G. A. R. in 1877; and first vice-president of the Society of the Army of the Tennessee in 1879.

Reynolds, Sir Joshua, English portrait painter: b. Plympton, Devonshire, 16 July 1723; d. London 23 Feb. 1792. He was the son of Rev. Samuel Reynolds, master of the grammar school at Plympton St. Mary, Plymouth, who intended him for the medical profession; but Reynolds declared himself for art and went to London in 1741 and studied under Thomas Hudson. This painter was at the head of his profession at a time when there were no very shining lights and from him Reynolds acquired a correctness of drawing and a certain reflection of the style of Van Dyck that gave way subsequently, in great measure, to other influences. He returned to Devonshire after two years and painted portraits for small prices; went again to London in 1745 and established himself as a painter, but the death of his father the following year recalled him to Plymouth. In 1749 he accompanied young Commodore Keppel, then sent on a mission to the Barbary states, to the Mediterranean and spent more than three years in Italy, mainly at Rome with visits to Florence, Bologna, Parma, Venice, and a short stay at Paris on his return to London. In Italy, he studied the Italian masters, especially in respect to their handling of light and shade. He learned from the Venetians much of their mastery of color, so that when he settled again in London in 1753 his work showed the influence of Correggio primarily with reminiscences of Tintoretto, Veronese, and Titian. In that year he painted a portrait of Commodore Keppel that lifted him at once into fame. This picture, now in the Grosvenor Gallery, is almost a monochrome in gray, with a few faint suggestions of color; but is remarkable for its effects of light and for individuality of portraiture. So popular did the young painter become that in 1755 120 persons sat to him for their portraits. His work, which is of such considerable extent, does not display a uniform excellence, since to produce it all he had to call in the assistance of journeymen. In 1768 he was made president of the Royal Academy upon its establishment; and the next year he delivered his first discourse to the students. His social success was commensurate with his fame as an artist; George III. knighted him and appointed him court painter in succession to Allan Ramsay. He lived on terms of intimacy with Dr. Johnson, Goldsmith, Burke, Gibbon, Garrick, and was the founder of the Literary Club in 1764 where these distinguished men assembled. His body lay in state in the Royal Academy and he was buried in St. Paul's Cathedral.

The mention of his portraits would include all the names famous in the upper world of society and the arts in his day, and there is no higher source for learning of the beauty of English women, the character of English men, and the fashions of taste of the later 18th century. He was graceful in arrangement of figures and accessories, was able in his portraits of men and women to differentiate a masculine vigor and a feminine charm, and in his mastery of color achieved a position, according to Ruskin, as "one of the seven great colorists" of the world. Posterity cannot fully appreciate his power in the latter direction, as he often used impermanent mediums and resorted to a thick impasto, which has cracked with time. His work is amply represented in the National Gallery and the National Portrait Gallery of London and the numerous great collections belonging to noble families. In America his pictures are to be found in fewer numbers in the larger museums and in the possession of private collectors. He published 'Discourses Before the Royal Academy' (1778), and 'Commentary on Du Fresnoy's Art of Painting.' His life was written by Malone (1798), Northcote (1813), Farrington (1819); but among recent biographies consult those by Claude Phillips (1894), Tom Taylor (1865), Sir Walter Armstrong (1900), Gower (1902).

Reynolds, William, American naval officer: b. Lancaster, Pa., 18 Dec. 1815; d. Washington, D. C., 5 Nov. 1879. He entered the navy as midshipman in 1831, was commissioned lieutenant in 1841 and in 1851 was retired in consequence of failing health. He was subsequently assigned to duty in Hawaii where he negotiated a reciprocity treaty, and at the outbreak of the Civil War was again assigned to active duty. In 1862 he received command of the Asiatic Station, was promoted captain in 1866, commodore in 1870, and rear-admiral in 1873. He was chief of bureau and acting secretary of the navy in 1873 and again in 1874; and in 1877 was again retired on account of continued ill health.

Rezonville, rė-zôṅ-vēl, **Battle of.** See GRAVELOTTE, and FRANCO-GERMAN WAR.

Rhabdocœlida, răb-dŏ-sē'lĭ-dạ, an order of *Turbellaria* which is characterized by the simple, unbranched, and rod-shaped alimentary canal. Some forms are very minute and often mistaken for *Infusoria*. Transverse fission is common in certain forms, and the power of regenerating lost parts is very great. A few genera have acquired a strictly parasitic habit, and a few also are marine and land forms, but most are inhabitants of fresh water. In many species two sorts of eggs are produced: summer eggs which are thin-shelled and are retained in the uterus until hatched, and winter eggs, which possess heavy brown shells, and, though produced in the fall, do not hatch out until spring. All *Rhabdocœlida* undergo a simple direct development.

Rhab'domancy. See DIVINATION; DIVINING ROD.

Rhadamanthus, răd-a-măn'thŭs, according to Greek legend, a son of Zeus and Europa, and brother of Minos, king of Crete. According to another tradition Rhadamanthus laid the foundation of the Cretan code of laws, which his brother Minos completed. From fear of his brother he is said to have fled to Ocaleia in Bœotia, where he married Alcmene. In the belief of the Greeks a spirit in the lower world continued the business of life, hence Rhadamanthus, after his death, was made a judge in the kingdom of Pluto, or the Islands of Blessed, on account of the justice of his life, and had for his associates Æacus and Minos. The name suggests an Egyptian origin of the myth.

Rhadames, rä-dä'mĕs. See GADAMES.

Rhætia, rē'shĭ-ạ, a Roman province comprising the regions of Rhætia proper and Vindelicia and extending from the land of the Helvetii in Gaul to Noricum on the west, and from Gallia Cisalpina to the Danube. It included within its bounds what are now the Grisons and the Tyrol, the southern districts of Bavaria and Würtemberg and the region of the Italian Alps, and contained the sources of the Rhine (Rhenus), the Inn (Alnus), and the Adige (Athesis), with many other rivers of northern Italy. The principal towns were Tridentum (Trent) in Rhætia proper and Augusta Vindelicorum (Augsburg) in Vindelicia. The original inhabitants of the country were considered by most ancient writers to be Etruscans who had been driven out of Italy by the invasion of the Gauls and who under their leader Rhætus took possession of the mountainous country. Modern research has tended to confirm the view of the ancients. The Rhætians were a brave and warlike people and their frequent inroads into northern Italy led to retaliation on the part of the Romans. After a bitter struggle they were subdued in 15 B.C. by Drusus and Tiberius, stepsons of Augustus Cæsar. With Vindelicia, which was conquered at this time, the southern region was united to form the province of Rhætia. Diocletian divided the province into two, giving to the southern part the name of Rhætia Prima, while Vindelicia was known as Rhætia Secunda. After passing into the power of the Ostrogoths in the 5th century the region was overrun by the Boiarii who settled in the eastern part, the Alemanni who occupied the west, and the Longobards who established themselves in the south.

Rhamnaceæ, răm-nā'sē-ē, an order of trees and shrubs. The species, of which about 500 have been described and classified in about 40 genera, are mostly natives of temperate and tropical countries, in which they are widely distributed, especially in the northern hemisphere. They are frequently spiny, have usually simple leaves and inconspicuous, small, greenish blossoms which are followed either by dry fruits which break at maturity into three parts, or by fleshy ones which do not split open when ripe. In several species the fruit is edible as in the jujube (*Zizyphus jujuba*). The red fleshy pear-flavored peduncles of *Hovenia dulcis* are eaten in Japan and China, where the plant is native. Some are important ornamental plants; for instance buckthorn (*Rhamnus*), and New Jersey tea (*Ceanothus*). Various species of the former genus are valued for the yellow and green dyes they yield and *R. frangula* for its charcoal which is used in making gunpowder.

Rham"nocathar'tin, in chemistry, the uncrystallizable principle of buckthorn berries, distinct from rhamnin, the crystallizable glucoside in the berry. It is an amorphous, yellowish, brittle mass, soluble in all proportions in water and alcohol, but insoluble in ether. It has a bitter and very repulsive taste, and, when heated, melts to a yellowish-brown oil, gives off inflammable vapors, and leaves combustible charcoal. Ferric chloride colors it dark green, and, when heated with nitric acid, it yields a large quantity of picric acid.

Rhampsinitus, rămp-sĭ-nī'tŭs, a Græcised form of the Egyptian name Rameses, Rameses III., the first king of the 20th dynasty and the builder of the pavilion of Medinet Habu at Thebes. Brugsch makes Rhampsinitos a Greek form of *Ramessu pa nuter* ("Rameses the God"); Maspero, *Ramsis-si-nit* ("Rameses, son of Neith"); by Diodorus he was called Remphis (Rempsis), from which comes the name Rameses by which Pliny called the monarch. Of him Herodotus (II., 121 *et seq.*) relates a story substantially the same as one of the most widespread folk-tales of the Aryan world. The king acquired an enormous treasure, and to secure it built a treasury of stone. The architect left one stone loose, so nicely adjusted as to be unnoticed, yet capable of being taken out and replaced without difficulty. Before death he entrusts the secret to his two sons, who from time to time plunder the king's treasure at their will, until at length the elder is caught in a snare set by the king. According to his desire, the younger brother cuts off and carries away his head, so that he may remain unknown. The king now orders the headless body to be exposed unburied, protected by a guard of soldiers, but the younger brother lades an ass with skins of wine, allows some of it to run out, and is relieved in his distress by the soldiers, to whom in gratitude he gives his wine so freely that they all sink into a drunken sleep. Thereupon he shaves the right half of all their beards, and carries his brother's body to his mother. The king next sends his daughter to find out the clever thief. She promises her love to those who reveal to her the most extraordinary things that have ever happened to them, and when the young man in his turn relates the strange passages of his life she seizes him; but he cunningly slips his brother's dead hand into hers, and so escapes. The king is so much struck with wonder and admiration that he promises the clever thief his daughter in marriage, since he surpassed all mankind in knowledge; for, while the Egyptians surpassed all the world, he surpassed the Egyptians.

The wealth of Rameses III. is said to have been equal to 400,000 talents, or $387,500,000, an incredible sum for those ages. It is represented on the walls of the palace treasury in the Medinet Habu as consisting of the precious metals and of wonderful jewels.

Herodotus gives the generally accepted story of the supposed thefts from the treasury, but his chronology and historical facts have been proven to be too inaccurate to be relied upon.

Rhap'sodists, a name given the wandering minstrels among the ancient Greeks, who sang the poems of Homer and those of other poets. They were for a long time held in high esteem, until the poems were committed to writing, and through the medium of manuscript copies became pretty generally known, when the rhapsodists soon lost their importance. Each ballad or recitation was termed a rhapsody, and thence it was applied to the separate books of the 'Iliad' and 'Odyssey.'

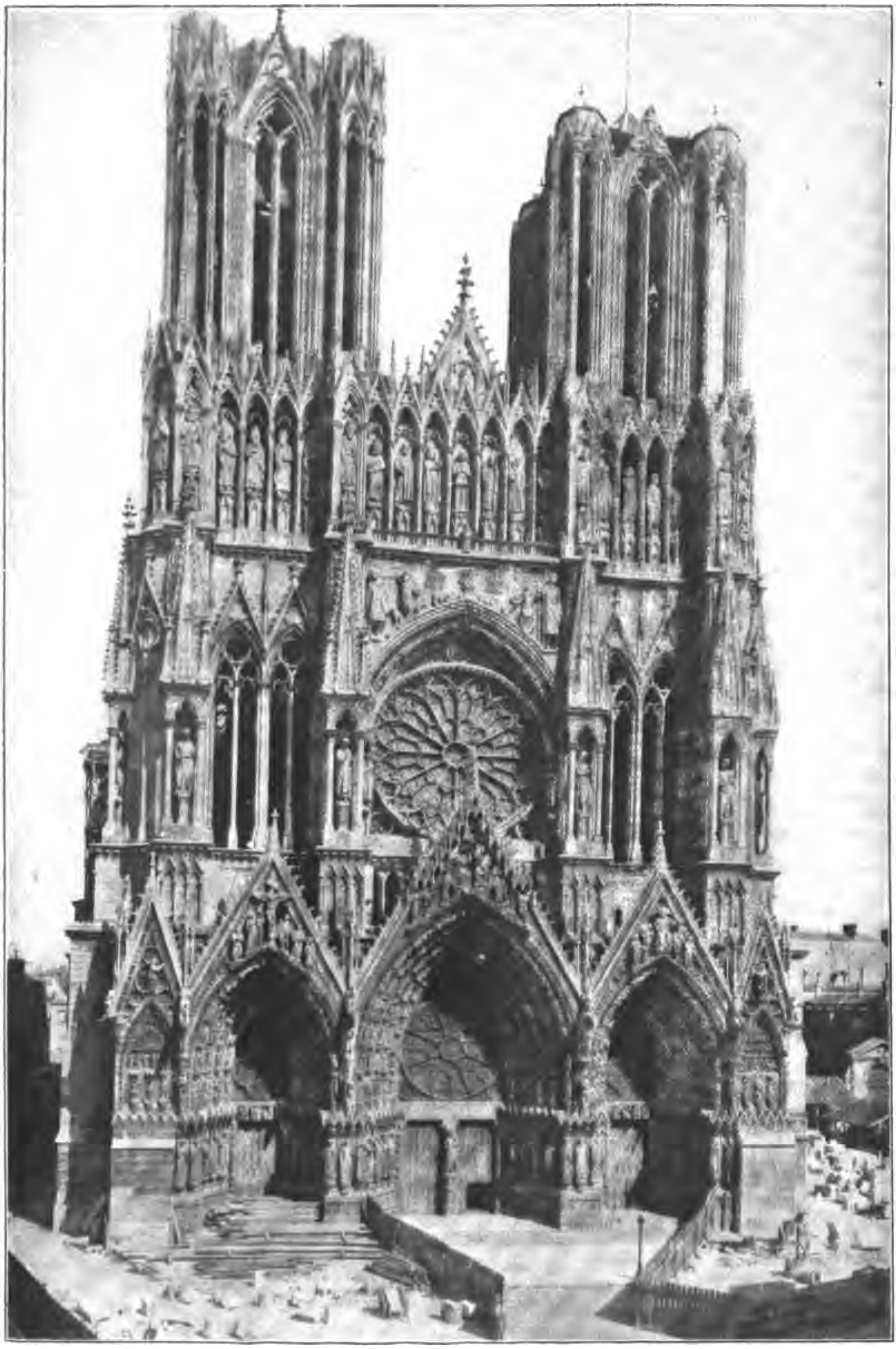
Rhat'any, or **Rattany**, shrub-like plants (*Krameria ixina* and *K. triandra*) of the order *Polygalaceæ*. They are natives of the Peruvian and Bolivian Andes, and are confined mainly to the table-lands of high altitudes. The roots are used extensively for coloring Portuguese wines and for mixing with charcoal or orris-root to be used as a dentifrice; and are an important article of export from Peruvian ports.

Rhazes, rā'zēs (Abu Bekr Mahammed Ibn Zakhariya Ar-Razi), Arabic physician: b. Rai or Raz (ancient Rhagæ), near Teheran, probably 923 A.D. He acquired great philological and philosophical knowledge, but studied chiefly music. Eventually he became expert in the medical science of his day, and was made director of the Bagdad hospital. There is a story that, when aged, he became blind, and refused to have an operation performed upon his eyes, because the surgeon about to undertake it could not tell how many membranes the eye contained. When it was urged that the operation might nevertheless succeed, he still refused, saying that he had seen so much of the world he was weary of it. The best known of the books that pass under his name is 'Al-Havi,' but its authenticity is questioned. His treatise on the smallpox and measles is the oldest account in existence of those two diseases. It has been translated several times into Greek and Latin, and into English from the Arabic text by Greenhill (1847). His 'Ketab Al-Mansuri' is a complete system of medicine drawn from Arabic and Greek sources.

Rhé, Île de, ēl dė rā. See **Ré, Île de**.

Rhea, rē'a, an ancient Cretan earth-goddess, daughter of Uranus and Gæa, wife of her brother the Titan Cronus, and by him mother of the Olympian deities Zeus, Hades, Poseidon, Hera, Hestia, Demeter. She was early identified with the Asiatic nature-goddess Cybele, the Great Mother, who was worshipped on mountains in Mysia, Lydia, and Phrygia. Her Cretan *Curetes* corresponded to the Phrygian *Corybantes*, many of whom mutilated themselves like Attis in the frenzy of their orgies. Rhea was supposed at first to make her home in the towering hills of Asia Minor. It was her delight to tame the ferocious beasts found in these wildernesses, as well as to protect the fair towns lying in their valleys. Thus she became known as Mater Turrita, and was represented as wearing a crown, turreted like a wall. Rhea's supposed love for the Phrygian shepherd, Attis, gave much color to her worship. In Pessinus, in Phrygia, there was a cave under Mount Dindymon, where was a large stone supposed to be the heaven-sent image of the goddess, as well as the tomb of Attis. This was the centre of her worship, and here the first temple to Rhea is said to have been erected by King Midas. From this centre the worship spread to the neighboring towns and provinces, finally reaching Athens. The worship of Rhea continued long after the decadence of Phrygian civilization. Its introduction into Rome, during the second Punic war, was the result of a prophecy of the Sibylline Fates which told that her image brought to Rome would expel a common foe. The stone in the cave at Pessinus was therefore placed in the Temple of Victory in the capital city, a holiday being proclaimed to celebrate the event.

Rhea, the generic and usual book-name of the South American ostriches or nandus, which, although true ratite birds and occupying the place of ostriches in the American avifauna, yet differ so greatly from the African species that ornithologists universally rank them as a distinct family (*Rheidæ*) or even order (*Rheæ*). Conforming to the general type of the ostriches, the rheas differ in having three toes with large claws, the head and neck fully feathered, the flowing plumes absent from the wings, and especially the tail, the ischiatic instead of the pubic bones forming the pelvic symphysis and the palatal structure peculiar in several respects. Three species of *Rhea* have been described; *R. americana*, found throughout the greater part of South America; *R. macrorhyncha*, which is confined to northeast Brazil and is distinguished by its darker color and longer bill; and *R. darwini*, of southern Argentina, which is smaller and has tarsi covered with small scales instead of scutes as have the others. The newly hatched young of the latter are said to have the legs feathered to the toes. Rheas are known to the natives as nandus or emas (the latter a corruption of emu introduced by the Portuguese), and live in small parties on the pampas and dry plains, where they associate with wild horses, deer, and guanacos. In general habits they closely resemble the ostriches (q.v.), but usually run with the wings lowered instead of



CATHEDRAL OF REIMS.

elevated. They are said to be able to swim across wide rivers. Because of the well-developed syrinx, which is absent in the ostriches, the male rheas have a loud, resonant call, especially heard during the mating season, when they also fight viciously. They are polygamous and the male incubates the score or more of eggs deposited by several females in one nest. They are omnivorous. Although lacking the precious plumes of the ostrich the feathers of the rhea have a commercial value in the manufacture of feather dusters. Many thousands are killed by shooting or with the bolos, or are run down with hounds or horses and clubbed to death. In many places they are threatened with extinction; but, although they breed readily in confinement, no efforts to raise rheas on a commercial scale appear to have been made. Consult: Darwin, ‹Voyage of the Beagle› (New York, 1889); Mosenthal and Harting, ‹Ostriches and Ostrich Farming› (London, 1877).

Rhea, or China Grass. See RAMIE.

Rhea Letter, The, in American history, a famous political episode of the time of the Monroe administration. On 6 Jan. 1818, Andrew Jackson, then army department commander in the Southwest, wrote to President Monroe regarding the Seminole troubles in Florida and advising the prompt seizure of East Florida, which he declared could be done «without implicating the government.» He offered to accomplish the seizure himself within 60 days, if it should be indicated to him that it were desirable. John Rhea, a congressman from Tennessee, was the secret channel through which he hoped Monroe's assent might be signified. It was not. In 1831, during Jackson's administration, in the height of his quarrel with Calhoun, which turned in part upon the Seminole affair, Rhea wrote to Monroe, hoping to elicit from him something that would implicate him as approving Jackson's plan. Monroe, on his death-bed in New York, denounced Rhea's insinuations as utterly false.

Rhead, Louis John, American artist: b. Etruria, Staffordshire, England, 1860. He was educated at the Art Training School, London, and in 1883 came to the United States to act as art manager for D. Appleton & Company. He has exhibited work in both oil and water colors in various American and European galleries and won a medal in Boston in 1895 for his artistic posters. He has illustrated many books, among them being: ‹Pilgrim's Progress›; ‹Idylls of the King›; ‹Robinson Crusoe› (1900); Dr. Hillis' ‹Psalms of David› (1900); etc.

Rheam, Henry Meynell, English artist: b. Birkenhead 13 Jan. 1859. He was educated in Germany and took up the study of painting at Heatherleys in 1884 and continued it in Paris under Bonguereau and Tony Robert Fleury. In 1890 he became allied with the Newlyn group of painters. His ‹Spells› was purchased in 1893 for the Walker Art Gallery by the Liverpool Corporation.

Rhees, rēs, **Rush,** American Baptist clergyman and educator: b. Chicago, Ill., 8 Feb. 1860. He was graduated from Amherst College in 1883, and from the Hartford Theological Seminary in 1889. He was pastor of the Middle Street Baptist Church, Portsmouth, N. H., 1889–92, and professor of biblical New Testament interpretation (1892–1900) in the Newton Theological Institution, Newton Centre, Mass. He was elected president of the University of Rochester, Rochester, in July 1900. He has published ‹The Life of Jesus of Nazareth: a Study› (1900).

Rhees, William Jones, American bibliographer: b. Philadelphia 13 March 1830; d. Washington, D. C., 13 March 1907. He was graduated from the Central High School of that city in 1847 and was in charge of the social statistics of the 7th census (1850–2). In 1852 he became chief clerk of the Smithsonian Institution of whose publications he had general charge. He wrote ‹Manual of Public Libraries, etc., in the United States and British Provinces in North America›; ‹The Smithsonian Institution›; ‹James Smithson and his Bequest.›

Rheims, rēmz, Fr. răṅs **(Reims),** France, in the department of Maine, 100 miles northeast of Paris. Strong forts crown the adjacent vine-clad hills. Its industries are considerable, embracing, besides champagne, the manufacture of textiles, dyeworks, breweries, distilleries, etc. It is also an important market for raw wool. The town was early imbued with a religious character owing to many solemn and historical rites celebrated in its great cathedral. Here the kings of France were successively crowned for many generations, and Clovis (438–533) was baptized within its walls. The façade of the cathedral is a mediæval masterpiece. A wealth of tapestry, sculpture, and paintings (Titian, Tintoretto, and Poussin) beautify the interior, and innumerable statues of artistic grace adorn the exterior. The rose-window and portal are of rare magnificence. The archiepiscopal palace, town-house and museum are notable buildings. Pop. about 110,000.

Rheingold, rīn'gōlt, **Das** («The Rhine-Gold»), a music drama by Richard Wagner, prelude to ‹Der Ring des Nibelungen.› It consists of four scenes, the first disclosing the depths of the Rhine, where on a high cliff rests the Rheingold guarded by the three Rhine-daughters. The possession of a ring wrought from this gold would give supreme power over the world; but in order to work the charm whereby the ring must be made, the one essaying it must have forsworn love. Alberich, the Nibelung, comes to the depths of the Rhine, and gains possession of the gold through the carelessness of its guardians. Scene II. reveals Wotan and Fricka before the castle of Valhalla, built for Wotan by the two giants Fasolt and Fafner. Straightway the two appear and claim as the promised reward of their labors Wotan's daughter Freia, the goddess of youth. Loge, the demigod of fire, who had persuaded Wotan into the contract with the giants with the assurance that he would provide some way of evading the payment, now appears, and reports that in his search over the world he had found that nothing in water, on earth, or in air would ever give up the love of woman; but that the Rhine-daughters had told him of Alberich, the present ruler of Nibelheim, who had forsworn the love of women and made himself a ring by power of which he had amassed great treasure. The giants, to whom Alberich of old was an enemy, offer to give up Freia in exchange for the Nibelung's treasure. Thereupon (Scene III.) Wotan and Loge, together with the two giants and Freia, descend to Nibelheim, make Alberich a prisoner, rob him of his treasure, his Tarnhelm, or cap of darkness, which Mime, his brother, has made for him, and also the ring, which Wotan places upon his own finger. The helpless Alberich curses the ring and prays that it may bring death and destruction upon every one into whose hands it comes. Freia is finally ransomed by the gold, the Tarnhelm, and also the ring, which Erda advises Wotan to add on account of the curse placed upon it. No sooner do the giants possess their treasure than they quarrel over its division, and Fafner strikes Fasolt dead, thus realizing the first curse of the ring. After a mighty storm summoned up by Donner (Scene IV.), the gods cross a rainbow bridge leading up to Valhalla, Wotan, plunged in thought, leading the way, while the voices of the Rhine-maidens are heard lamenting the loss of their gold.

This work was performed first (without authorization) at Munich in 1869; then at Baireuth in 1876; for the first time in America, at New York, in 1889. It contains remarkable passages of instrumentation, especially in the introduction, which consists of 136 measures running throughout in the chord of E-flat major.

Rhenish (rĕn'ĭsh) **Architecture.** See GERMANY, *Architecture.*

Rhenish Confederation. See CONFEDERATION OF THE RHINE.

Rhenish Prussia. See RHINE, PROVINCE OF THE.

Rhe'ostat, in electricity, an instrument invented by Wheatstone for measuring electrical resistances. Two rollers, one non-conducting, and the other of brass, are geared together, so that when either is turned by means of a handle a fine copper wire will be uncoiled from one roller as it is wound upon the other. Two binding-screws, one of them in contact with the brass cylinder and the other with the end of the wire on the non-conducting cylinder, connect the apparatus with the wires of the battery. To use the rheostat, the resistance to be measured is put in circuit with a constant battery and a galvanometer, and the indication of the galvanometer is noted; the resistance is then removed from the circuit, and the rheostat is put in its place, and the handle turned till the galvanometer gives the same reading as before; the resistance of the rheostat is now the same as the resistance which was to be measured, and it is measured by the number of coils of copper wire on the insulating roller.

Rheot'ropism, that tendency in plants which leads their roots, when immersed in running water, to curve in accordance with the current. Positive rheotropism causes the roots to curve up stream; and negative rheotropism produces the opposite curvature.

Rhe'sus or Bengal Monkey, a common Indian macaque (*Macacus rhesus*). It is a strong species with powerful limbs, but without the ruff or beard found in some allied species. The body attains a length of about two feet, and the tail is of medium length. Brown is the prevailing color, but the bare face and the callosities are flesh-colored or red. The rhesus monkey is very intelligent and mischievous, and the young ones can be easily tamed. In several parts of India the Hindus protect this species, for which they have a great veneration.

Rhetoric, the art of correct speaking and writing, of using language not only correct as to grammar, but best adapted to convey the effect desired by the speaker or writer. The term «rhetoric» is, however, usually applied to spoken discourse, which may either be a simple statement of fact or theory to one or more persons, or an oration intended to make a profound impression on a vast multitude of hearers and readers. An oration may be powerful and at the same time ungrammatical; in such case it is outside the bounds of rhetoric, in the strict meaning of the word. He who cultivates rhetoric must keep within the recognized rules of language. He must be grammatical as well as logical. Rhetoric includes, along with correct expression, the acquirement of a clear and pleasing style, and attractiveness in presenting a subject. It is, in brief, the art which aims to bring to highest perfection the attribute of speech, which distinguishes man from all other animals, and which is the chief instrument of human progress and achievement. In ancient and modern times, rhetoric has therefore been regarded as one of the noblest studies. Among the Greeks Aristotle and Longinus were the great masters of rhetoric, and Aristotle's 'Art of Rhetoric' still remains the ablest analysis ever written of the mental and ethical characteristics of oratory. Among the Romans Cicero held the palm as an authority on this subject. It was not emphasized in the Middle Ages, but in modern times it has again arisen to importance, and every leading institution of learning has its chair of rhetoric. In no country in the world is the art of rhetoric more generally cultivated than in the United States, owing to the freedom of speech and of the press, and to the fact that effective oratory is almost certain to command public preferment. The student of rhetoric should consult Blair's 'Lectures on Rhetoric,' Campbell's 'Philosophy of Rhetoric,' and other standard works on the art, and he may study also with the best results the orations of Webster, Clay, and other great speakers, the messages and addresses of Lincoln, Washington's 'Farewell Address,' and other well known examples of pure and vigorous English.

Rhett, rĕt, **Robert Barnwell,** American politician: b. Beaufort, S. C., 24 Dec. 1800; d. Saint James' Parish, La., 14 Sept. 1876. He was the son of James Smith, but in 1837 adopted the name of Rhett, a prominent colonial ancestor. He studied law, was elected to the legislature in 1826, and in 1832 was elected attorney-general of the State. He was one of the leaders of the Nullification movement and a more strenuous advocate of States' right than even Calhoun. In 1837–49 he sat in Congress and in 1850 was elected to succeed Calhoun in the Senate. He stoutly upheld slavery, opposed all compromises, and in 1851–2 he urged the secession of South Carolina, whether accompanied by other States or not. After the elections of 1852 Rhett resigned from the Senate and retired to his plantation. He later edited the Charleston 'Mercury' in which he advocated his extreme views, and in 1860 he again came into prominence as a member of the South Carolina Convention and was one of the committee which wrote the address giving reasons for secession. He was a delegate to the provisional congress at Montgomery, Ala., in 1861, and later an active member of the Confederate Congress. He removed to Louisiana after the war.

Rhett, Thomas Grimke, American military officer: b. South Carolina about 1825; d. Baltimore, Md., 28 July 1878. He was graduated from West Point in 1845, served in the Mexican War, was brevetted captain for conduct at Puebla in 1847 and in 1858 received rank as major. In 1861 he resigned his commission in the United States army and was commissioned major-general by the governor of South Carolina. He was chief of staff to Gen. Johnston until 1862 and was then assigned to the trans-Mississippi department. He served as colonel of ordnance in the Egyptian army in 1870–3 and then resigned.

Rheumatism, a constitutional disease characterized by inflammation of the connective-tissue structures of the body, especially of the joints and muscles, and attended by localized pain. It is usually recurrent. Three forms are recognized: (1) acute rheumatism (acute articular rheumatism, acute inflammatory rheumatism, rheumatic fever); (2) chronic rheumatism; (3) muscular rheumatism or myalgia.

Acute rheumatism is marked by high fever, inflammation and swelling of one or more of the larger joints, intense pain, increased by movement, profuse sweating, scanty high-colored urine, and a tendency to inflammation of the endocardium (endocarditis) and of the pericardium (pericarditis). In many cases there is apparently a hereditary tendency; in others, sudden checking of perspiration in a cold and damp atmosphere may cause the disease. Conditions which lower vitality, such as chronic alcoholism, nervous debility, or poverty associated with exposure and insufficient food, are predisposing causes. More males than females have acute rheumatism, probably because of more hardship and exposure. It is quite common among farmers, longshoremen, coachmen, stokers, motormen, sailors, scrub-women, etc. It most frequently occurs between the ages of 15 and 30, is rare before the 10th year and after the 50th. An injury to a joint, or excessive muscular work, may be the initial cause. The disease is rare in the tropics, common in the temperate zones; in the United States it is most frequent in the early spring and late fall; and it is often endemic and sometimes epidemic.

The specific cause or origin of rheumatism is not known. That it is always due to an arthritic diathesis, inherited or acquired, is a theory not generally accepted in this country. The infection theory of Hueter, though accepted by many, is not generally adopted. As to the chemical theory, that the disease is due to an excess of lactic or uric acid in the blood, some believe that the acids are due to bacterial activity; others, that all the phenomena of rheumatism cannot be produced by one chemical substance. The nervous theory, not fully recognized, assumes that the joint-lesions are trophic, owing to disturbances of the nervous system, from the action of cold on nerve-centres, etc. The morbid anatomy shows characteristic disorders of the joints — synovial membrane swollen and hyperæmic; serous infiltration of ligamentous and other tissues; joint-fluid turbid with albumen, fibrin and leucocytes (pus and blood rarely present); sometimes ecchymoses on cutaneous and serous surfaces. In the blood the red corpuscles are reduced more than one half; the hæmoglobin is much less than normal; but fibrin and leucocytes are largely increased. The heart is affected in very many cases, most frequently the left side (rheumatism of the heart), the edges of contact of the mitral valves being swollen and covered with fibrinous masses; less frequently, the aortic valve; rarely, the pulmonary or tricuspid. Contraction and distortion of the affected valves may result. Ulceration is rare. Simple fibrinous or sero-fibrinous pericarditis is common; myocarditis seldom occurs. The attack may begin with headache, indigestion, aching, chilliness, slight tonsillitis or pharyngitis, but usually comes with a chill, followed soon by high fever (may be 103° or 104° F.), swelling, tenderness, heat, and shiny appearance of one or more joints (knees most often, then wrists and fingers, ankles, etc.), a coated tongue, foul breath, a soft pulse of 100 to 110, thirst, constipation, and by profuse sour sweat. If not treated, the disease lasts from two to three weeks. There is always a tendency to recurrence, complications, and migration from one joint to another. The mind is clear, except when the fever is very high. Coma, which is rare, is due either to high fever or nephritis.

So-called cerebral rheumatism is due to a toxic congestion. Sometimes urticaria and spots of ecchymosis appear upon the skin, and in children small nodules, firm but movable, are attached to tendons and fasciæ, and are found over the spine, scapula, and inflamed joints.

Follicular tonsillitis is considered by some to be due to rheumatism. But the most serious complications of acute rheumatism are endocarditis and pericarditis. Other complications are chorea, conjunctivitis, pleurisy, bronchitis, peritonitis, orchitis, etc.

There is a sub-acute rheumatism, very common, with mild symptoms and slow recovery. It may follow an acute attack or be sub-acute from the outset, and may pass into the chronic form. Temperature is seldom above 102° F. The so-called acute rheumatism of children is usually sub-acute; the joint-symptoms may be so slight as to be readily overlooked, but there is more liability to cardiac inflammation than in adults. Children perspire less, but are liable to have chorea, tonsillitis, and cutaneous manifestations.

Acute rheumatism is to be distinguished from arthritis following scarlet fever and other acute diseases; from acute osteomyelitis, scurvy (in children), gout, arthritis deformans, and gonorrhœal rheumatism.

Severe cases may recover within a week; and mild cases last several weeks. The joints are not left with fibrinous adhesions unless chronic rheumatism supervenes. Death is rare, and when it occurs it results from high fever, pneumonia, pleurisy, or myocarditis. Relapses are quite common. Treatment requires many details. Among preventive measures are care against exposure to cold and damp, especially when overheated; freedom from muscular strain; the wearing of woolen underclothing in winter, and of linen-mesh in summer; abstinence from sweets and malt liquors; very moderate eating of animal food; sponging with cool water, followed by friction; outdoor exercise; and the keeping of the bowels open with Carlsbad water or Rochelle salt. During the attack place the patient between blankets on a comfortable mattress; have him use a bed-pan; carefully dispose the inflamed part in a comfortable position. While the disease is severe give light food, no meat, sweets, or malt liquors; allay fever with cool spongings, and tincture of aconite; quiet the patient with Dover's powder or codeine; locally apply methyl salicylate, oil of wintergreen, or equal parts of guiacol and glycerin; and keep the part warm with cotton batting, oil-silk, etc. Medicinally, salicin, salol, or salicylate of soda and bicarbonate of potassa or soda, or the citrate of potassa seem to be of most avail.

Chronic rheumatism is a form of chronic joint-inflammation, attended by moderate pain, and by changes in the joints resulting in their deformity. It begins insidiously, or follows attacks of acute or sub-acute rheumatism, and is rare before the 40th year. The predisposing causes are poor hygienic conditions, debility, malnutrition, cold and damp, and occupations which involve the repeated and long-continued use of certain joints, as in the cases of seamstresses and tailors. A moderate thickening and some distortion appear in affected joints (fingers and knees especially) which may be bilateral. The changes are mainly in the fibrous tissues, though sometimes there is synovial injection and effusion. Erosion of cartilages is seen only in prolonged cases. Endocarditis, pericarditis, and pleurisy are rare.

The symptoms slowly develop; general health may be good; pain occurs when joints are red and swollen, and may be severe at night. Joints swell from time to time, and some persons readily predict an attack. The muscles about the joints after a time atrophy and the affected joints are deformed by deflection due to adhesions. Slight fever may accompany attacks. The diagnosis excludes gout and arthritis deformans (qq.v.).

In treatment medicine is of uncertain value. Iron, Vichy water, iodide of potassium, and Carlsbad salts or phosphate of soda may be used. More relief is to be obtained from douching and sweating of the joints, massage, protection against cold and damp and injuries to the joints, an ample diet (no sweets, and no alcoholic stimulant except whiskey), a dry equable climate, and residence at one of the spas.

Muscular rheumatism, or myalgia is a painful affection of various voluntary muscles and of the fasciæ and periosteum to which they are attached. It is most common in youth and young adults and among those exposed to cold and damp when overheated, and those who overuse certain muscles. Heredity, goutiness, and lithæmia are predisposing causes. The disease is never fatal, whether it is neuralgic in character or is an inflammation of muscular tissue (myositis) is not determined. The symptoms include local pain and tenderness, increased by contraction or movement of the affected muscle; usually the pain is an intense dull ache. There is seldom any heat, swelling, or redness. Occasionally the muscle cramps and is most comfortable if semi-flexed. Sometimes there is fever. In torticollis or stiff-neck (unilateral) some of the muscles of the neck are involved. The patient dreads to move the head, and moves the body instead. In pleurodynia one side is affected (generally the intercostal muscles, but sometimes in the serratus and pectoralis), usually the left. Pain is increased by movements, coughing, or sneezing.

Lumbago, a muscular rheumatism affecting the muscles of the lumbar region and their tendinous attachments, is bilateral, quite frequent, and is often caused by strain of the muscles of the loins. An attack often begins suddenly with an excruciating pain when the sufferer is attempting to rise from a sitting posture, or to change his position in bed. If the loin-muscles are kept rigid the patient may be able to move about. Treatment calls for rest of affected muscles (best in bed), the application of heat and anodyne liniments, ironing the loins with a hot flatiron over a few thicknesses of flannel or thick wrapping paper, or galvanism.

Muscular rheumatism is distinguished from neuralgia by localized pain, increased by voluntary movements, and by the absence of tender spots. Recovery usually occurs in a few days, except in debilitated persons, those with rheumatic tendencies, or subjects of chronic alcoholism.

Preventive treatment requires freedom from damp and cold, and from muscular strain, sponging and friction, vegetable diet, and warm underclothes. Massage and a Turkish bath may prevent an attack. For local treatment rest, heat, turpentine stupes and anodyne liniment are of use. Medicine is of little value. In pleurodynia, strapping the chest, or the use of a wide flannel binder, is often of much service.

Rheumatism-root. See Twin-leaf.

Rheydt, rīt, Germany, a town of Prussia, in the government of Düsseldorf, 16 miles west of Düsseldorf, important on account of its industries, which embrace silk and satin goods, cottons, and mixed fabrics, foundries and machine-shops, printing and dyeing works, breweries, distilleries, etc.

Rhigas, rī'gas, **Constantine,** Greek patriot: b. Velestino (the ancient Pheræ) about 1753; d. Belgrade, Servia, 1798. He wrote not only in Greek but also in French, and was a poet and a proficient in music. He formed the bold plan of freeing Greece from the Ottoman Porte by means of the secret association of the Hetæræa, and succeeded even in bringing powerful Turks into his conspiracy. From Vienna he kept up a secret correspondence with the most important confederates in Greece and in other parts of Europe. At the same time he composed in his native language a number of patriotic songs, calculated to inflame the imagination of the Greek youth and embitter them against the Mussulmans. Having been arrested in Trieste he was with several other prisoners conducted to Vienna. Rhigas and three others of those arrested were sent back in chains to Belgrade in May 1798, and put to death by the Turkish authorities. During the Greek war of independence, which ultimately led to the emancipation of their country from the Turkish yoke, his songs were in the mouth of everyone. The most celebrated of them are his translation and adaptation of the 'Marseillaise.' Consult: Edmonds, 'Rhigas Pheraios, the Protomartyr of Greek Independence' (1890).

Rhine, rīn, a river of Germany, and until the Franco-German war of 1870–1, the boundary for a part of its length between France and Germany. It is one of the most picturesque rivers in the world, and its natural beauty is heightened by the historic and legendary traditions with which its name is associated. Its direct course is 460 miles long and its indirect course about 800 miles; the area of its basin is about 86,600 square miles. It is formed in the Swiss canton Grisons by three main streams called the Vorder, Mittel, and Hinter Rhein, or the Upper, Middle, and Lower Rhine. The Vorder Rhein rises in the small Toma Lake (7,690 feet high), lying to the northeast of the St. Gothard, and is augmented by two streams which unite with it near Chiamut (5,380 feet). The Mittel Rhein issues from a small lake west of the Lukmanierberg, traverses the Medelserthal, and joins the Vorder Rhein at Disentis, from which point the united stream is called Vorder Rhein. It takes an easterly direction, and at Reichenau unites with the Hinter Rhein, which issues from the Rheinwald Glacier, in the Adula group, and has a course of about 70 miles through the Rheinwaldthal before reaching Reichenau. Here the stream takes the name of Rhine, has a width of 130 to 140 feet, and admits of floating. The Rhine first becomes properly navigable at Coire after receiving the Plessur. It now turns north, and shortly after being augmented by the Landquart quits the Grisons, forms the boundary between the canton of St. Gall on the left and Liechtenstein and Vorarlberg on the right, receiving the Ill from the latter, and enters the Bodensee or Lake of Constance, continued by the Untersee. On issuing from the Untersee it flows west, separating Switzerland from the grand-duchy of Baden, and continues its course to Schaffhausen and Basel, receiving, as it proceeds, on the left the Goldach, Thur, Thöss, Glatt, and Aar, and on the right the Wutach and Alb, mountain streams of the Black Forest. At Schaffhausen the river forms perhaps the grandest waterfalls in Europe. At Basel it again begins to flow north, when it separates the German territory of Alsace from Baden, forms the boundary between the latter and the Bavarian palatinate, flows thereafter through the grand-duchy of Hesse, forms the boundary first between it and Nassau, and then between Nassau and the Prussian Rhenish province, till it wholly enters the latter at Coblentz. Below Emmerich it enters the Dutch province of Gelderland, and shortly after divides into two branches, a south and a north. The south, called the Waal (anciently Vahalis), carries off two thirds of its water, and joins the Maas or Meuse at Woudrichem. The north branch, after making several windings in its course to Arnhem, but still retaining the name of Rhine (Rijn), divides at Westervoort, before reaching Arnhem, into two branches. Of these the right proceeds as the New Yssel, in the bed of the canal which Drusus dug to connect the Rhine with the Old Yssel, till it reaches Doesburg, where the New and Old Yssel unite to pour their accumulated waters into the Zuyder Zee. The left arm proceeds, under the name of Rhine, in a course nearly parallel to the Waal, passing Wageningen and Rhenen to Wijk-by-Durstede, where it again bifurcates, sending a very feeble branch, under the name of the Crooked Rhine, to Utrecht, where, by the canal of Vaart, it communicates with the much larger branch, called the Leck, and flowing past Vianen and Schoonhofen unites with the Maas above Grimpen-op-de-Lek. The Crooked Rhine becomes little better than a ditch; on leaving Utrecht it proceeds toward Leyden, and at the beginning of the 19th century was lost in the sand beyond Katwijk-aan-den-Rijn. At an earlier period it had here found an outlet into the ocean; and in more recent times, after surmounting many difficulties, the lost water of the Rhine has been collected in a canal, and by the aid of three sluices the outlet has again been established. The breadth of the Rhine and the character of its channel differ much at different parts of its long course. Its breadth at Basel is 750 feet; between Strasburg and Spires from 1,000 to 1,200 feet; at Mainz 1,500 to 1,700 feet; and at Schenkenschanz, where it enters the Netherlands, 2,150 feet. Its depth varies from 5 to 28 feet, and at Düsseldorf amounts even to 50 feet The Rhine abounds with fish, including salmon and salmon-trout, but more especially sturgeon, lampreys, pike, and carp. Wild fowl also abound on its banks and countless islands. Some gold is contained among the sands brought down into it from the mountains of Switzerland and of the Black Forest.

The navigation of the Rhine is very important, particularly for west Germany. The navigation is rendered dangerous by waterfalls, more especially those of Schaffhausen, of Zurzach (near the mouth of the Wutach), of Laufenburg, and of Rheinfelden; it is also rendered dangerous by the Bingerloch, near Bingen, where the stream becomes suddenly narrowed and confined between lofty precipices, and by similar causes, though in a less degree, at Bacharach, St. Goar, and at Unkel.

The Rhine is distinguished alike by the beauty of its scenery and the rich fields and vineyards which clothe its banks. Hence no river in Germany, more especially since the introduction of steam-vessels, attracts so many tourists. From Basel to Mainz it flows through a wide valley, bounded on the left by the Vosges, and on the right by the Black Forest and the mountains along the Bergstrasse. From Mainz the mountain ridges approach the stream at first only on the right bank, where they form the Rheingau; but at Bingen they begin to hem in the left bank also, and continue from thence to Königswinter to present a succession of lofty mountain summits, bold precipices, and wild romantic views. Pleasant towns and villages lie nestled at the foot of lofty hills; above them on all sides rise rocky steeps and slopes clothed with vines, and every now and then the castles and fastnesses of feudal times are seen frowning from precipices apparently inaccessible. At times the chain of ridges on either side opens out, and allows the eye to wander into romantic valleys, along which tributaries of less or greater magnitude keep dashing down or gradually winding to the parent stream. On the river itself much additional variety and beauty are given to the scenery by the constant recurrence of picturesque and verdant islands.

Scarcely a river in the world is of importance to more people than the Rhine. Since long before Cæsar's day this great stream has been the scene of stirring events in the world's drama.

Vercingetorix, Charlemagne, Tilly, Wallenstein, Frederick the Great, Napoleon Bonaparte, Bismarck, and Moltke, these are some of the illustrious names in the long roll of warriors who strove along its banks for command of this great highway. Famous in song and story, lined with great cities and ruined castles of robber barons, it is the Mecca of tourists at all seasons of the year. Up one side and down the other, or by river from Cologne to Mainz, every mile has its beauties and its legends. Between Darmstadt and Heidelberg the Taunus Mountains shut in its basin on one side, the Odenwald, scene of the Siegfried saga of Wagner's Nibelungen operas, on the other. An ideal region for the man fond of walking tours, for the villages are so close together that no spot along its banks is more than an hour's walk from a village. Cyclists and automobilists find good roads, generally military highways, all the way from Holland to Basel and the Lake of Constance.

Rhine, Confederation of. See Confederation of the Rhine.

Rhine, Province of the, or Rhenish Prussia (Ger. *Rheinland*), the westernmost province of Prussia, touching west and north, Luxemburg, Belgium, and Holland; greatest length from north to south about 200 miles, greatest breadth about 90; area, 10,423 square miles. It is divided into five governments or districts, Coblentz, Treves, Cologne, Aachen (Aix-la-Chapelle), and Düsseldorf. The city of Coblentz is the official capital of the province, but Cologne is the town of most importance. The southern portion of the province is hilly, being traversed by the ranges of the Eiffel, Hochwald, etc. It is watered by the Rhine, the Moselle, and some affluents of the Meuse. A large proportion of the surface is in forest. Besides the usual cereal crops, tobacco, hops, flax, rape, hemp, and beet-root are raised; fruit culture and the vine culture are also carefully attended to. Cattle are extensively reared. It is the most important mineral district in Germany, abounding in coal, iron, lead, zinc, etc. It is likewise an active manufacturing district, there being numerous iron works and machine shops, textile factories, breweries, distilleries, etc. Pop. about 5,759,000, the majority Catholics.

Rhine Wines. See Wines.

Rhinelander, rīn'lăn'dėr, Wis., city, county-seat of Oneida County; on the Wisconsin River, and on the Saint Paul & S. S. M., and the Chicago & N. R.R.'s; about 100 miles northwest of Green Bay. The Pelican Rapids in the Wisconsin at this place furnish extensive water-power. It is in a lumbering region, and its chief manufacturing establishments are lumber mills, which have about 500 employees; paper mills, 175 employees; refrigerator works, 75; boat building works, 30; iron works, 20; and minor industries, 250 employees. There are seven churches, Saint Mary's Hospital, seven public schools, one parish school, and a Carnegie Public Library. The two banks have a combined capital of $100,000. The government is vested in a mayor and 12 aldermen. Pop. (1890) 2,658; (1900) 4,998. In 1910 the population was 5,637.

Rhini'tis. See Nose and Throat.

Rhinoceros, a massive hoofed mammal of the family *Rhinocerotidæ*, characterized prominently by its nasal horns, the species of which are now confined to South Africa and south-eastern Asia, although in past ages of world-wide distribution. These animals are all of large size and ungainly form, and the very thick skin is usually thrown into folds of more or less definite kind, and as a rule is very sparsely haired. The limbs are stout and comparatively short, and terminate in round feet with three toes on each foot, each toe encased in a hoof. The skull is of pyramidal form, with a confluent orbit and temporal fossa, and the nasal bones are very prominently developed, and support one or more "horns," which grow one behind the other. The muzzle is extended by a more or less elongated pointed and prehensile upper lip; the incisors and canines are diminished but functional in the African species, and entirely wanting in adults of the Asiatic species. The cheek-teeth are massive and their crowns exhibit complexly folded ridges, varying much with the species. The horn of the rhinoceros is of epidermic origin, based upon thickened "bosses" of the underlying bone, but really formed of fibres of horn practically bristles, agglutinated as they grow. When two horns are developed, the hinder one is borne by the frontal bones, and is situated in the middle line behind the front horn. The front horn is generally much larger than the hinder one, the latter, when larger, possessing a different shape from the front structure. They serve many useful purposes in savage economy, but are of little service in civilized arts, although formerly the horn was considered to have medicinal and even magical virtues, especially in the detection of poisoned wine.

Indian Rhinoceros (*Rh. indicus*).

Although subdivided by some zoologists, the rhinoceroses may properly be regarded as forming only a single genus, *Rhinoceros*, with five existing species, and some extinct species, to which must be added several genera known only by fossil remains.

The most familiar species is the typical one-horned or Indian rhinoceros (*Rh. indicus*), which, like all the Asiatic species, has the skin thrown into very definite folds, corresponding to the regions of the body. The horn of this species is black, very thick, from one to (rarely) two feet long, and rises from the tip of the nose. The upper lip is very large, and overhangs the lower; it is furnished with strong muscles, and is employed by the animal somewhat as the elephant uses his trunk. The skin is naked, rough, extremely thick, and of a purplish brown hue. About the neck it is gathered into large folds; a fold also extends between the shoulders and fore-legs, and another from the hinder part of the back to the thighs. It is naturally soft and easily penetrated by a rifle-ball or hunting knife, but when suitably dried is exceedingly hard and polishable. The tail is slender, flat at the end, and furnished at the sides with very stiff black hairs. This animal was well known to the ancients when it ranged over most of the peninsula of India, and was introduced into the games of the circus by Pompey. From the time of the fall of the Roman Empire, however, it was lost sight of so completely, that, prior to the 16th century, naturalists were of opinion that it had never existed, or, if so, that it was extinct. When the Portuguese, however, opened the way to India, these animals again became known, and many were introduced into Europe, a historic one, sent by an Indian potentate to the king of Portugal in 1513, stood as model for a well-known drawing by A. Dürer. This species is now much restricted in range, and not to be found outside of the plain of Assam, where it confines itself to the marshy grass-jungles, where, like its relative, the tapir, it is fond of wallowing in the mud. Though possessed of great strength, and a match for either the tiger or the elephant, it is quiet and inoffensive unless provoked. The female produces one at a birth. The growth of the young is very gradual, as, at the age of two years, it scarcely attains half the height of the adult, which is usually about five feet at the shoulder; such a specimen will measure about 9½ feet from the snout to the root of the tail. The sight of this rhinoceros is by no means acute, but, on the contrary, its senses of smelling and hearing are very keen. Its chief food is canes and shrubs. The flesh somewhat resembles pork in taste, though of a stronger flavor and coarser grain. It can be successfully hunted only by the aid of elephants, and is now protected by law against extermination. It lives well in captivity, and specimens may be seen in many zoological gardens, but it does not breed in captivity.

African Rhinoceros (*Rh. bicornis*).

The Javanese or Sondaic rhinoceros (*Rh. sondaicus*) is distinguished from the Indian species by smaller size, shorter horn, and differences in the disposition and tesselated appearance of the skin-folds, which is also somewhat more hairy. It occurs in the Sunderbunds of India, in Bengal, and in the Malayan Islands. The Sumatran rhinoceros (*Rh. sumatrensis*) is well distinguished by having two horns, the rear one like a big knob, and in being clothed with a comparatively thick coat of hairs. Its range is similar to the Sondaic species, but it also extends to Borneo. A variety living in the Assamese swamps has been called the hairy-eared rhinoceros (*Rh. lasiotis*). The upper lip of this species forms a short proboscis and it gets its food mainly by browsing shrubs.

The African rhinoceroses are two, both differing from the Asiatic group in dentition, and in the absence of the armor-like plates and folds in the hide, which is hairless and lead-colored. Considerable variation exists, so that half a dozen or more distinct forms have been named, but all seem referable to two species,— the ordinary widespread African rhinoceros (*Rh. bicornis*), and the square-mouthed (*Rh. simus*). The former is to be found, except where killed off by civilization, throughout all southern and eastern Africa outside of the equatorial forests, and it does not show the fondness for swamps which characterizes the Asiatic congeners. Its front horn is broad and raised as on a base, sharp-pointed, and curved slightly backward, while the hinder horn is usually shorter and more conical. The head is rounded. This animal appears to be of ferocious disposition, and is quick and active, and greatly feared by the natives. The food consists largely of roots, which it digs out of the earth by aid of its horn. The side of the horn is thus frequently rubbed by contact with the earth. This long horn may attain a length of 3 to 3½ feet, and straight ramrods are made from it. The lip is somewhat pointed and prehensile, and the animal browses much of the time. It is justly regarded by hunters as one of the most dangerous animals in the world to meet, and it often charges from ambush, or dashes frantically through a camp, so that many persons have lost their lives by it outside of chosen encounters.

The square-mouthed, white, or Burchell's rhinoceros is a northerly, and now almost extinct species (*Rh. simus*), which dwelt in East Africa and was distinguished by its huge size, a male standing 6½ feet high at the shoulder, with the front horn 50 or more inches in length. Its muzzle is short and square, the upper lip being short and its food consisting altogether of grass. Its general habits otherwise are similar to those of the other species.

Fossil Rhinoceroses.— These animals begin to be recognizable toward the end of the Eocene Period, both in Europe and North America; but the first form of which much definite knowledge is possessed is *Hyracodon* of the Lower Miocene (White River beds) of the eastern slope of the Rocky Mountains. This was a comparatively small, slightly built animal with a longer neck and limbs than later rhinoceroses show, and no trace of a horn is perceptible. Like other early forms it was tridactyl, but in some a rudimentary fourth toe (the 5th) remains on the fore foot. "In North America," says Woodward, "a normal horn does not appear ever to have been acquired, and the race disappeared before the close of the Pliocene. . . . In the Old World, however, the gradual development of the horn can be clearly traced." The earliest definite European remains are of a hornless rhinoceros (*Aceratherium*), which seems to have ranged over all Europe and Asia, and very similar species lived simultaneously in western North America. One of the latter (*Diceratherium*), of small size, had two callosities on its nose side by side, and four digits in the front foot. Typical horned rhinoceroses are to be traced as far back as the middle of the

Miocene, and they had all the essential features of the modern ones, and no one-horned fossils have been found outside of the Indo-Malayan region. The upper Pliocene species bore horns so large that the septurn between the nostrils was ossified for their support. This feature is noticeable in the species (*Rh. leptorhinus*) common in England in the time immediately subsequent to the Ice Age; and reaches its maximum in the great woolly rhinoceros (*Rh. tichorhinus*), whose bones are found in the cave deposits and river gravels from Great Britain to China, and whose mummified remains have been taken, like those of the mammoth, from the ice-cliffs of arctic Siberia. It had immense horns and was covered with dense woolly hair. Another huge, but aberrant rhinoceros (named *Elasmotherium*) roamed over Russia and northern Asia at the same Pleistocene period, which was sometimes 15 feet long, and bore an immense horn rising from between the eyes.

Bibliography.— Consult authorities on zoology and sport in India, especially Blanford, ‘Mammals of India’ (1888); and in Africa, especially the writings of Selons and Baker; Flower and Lydekker, ‘Mammals Living and Extinct’ (1891); Woodward, ‘Vertebrate Palæontology’ (1898).

Rhinoceros-bird, some bird, especially a small white egret, which perches upon the rhinoceros when at rest, searching his hide for ticks and other insects, and warns him by its cries of the approach of any intruder. Compare BUFFALO-BIRD.

Rhi'noscopy. See NOSE AND THROAT.

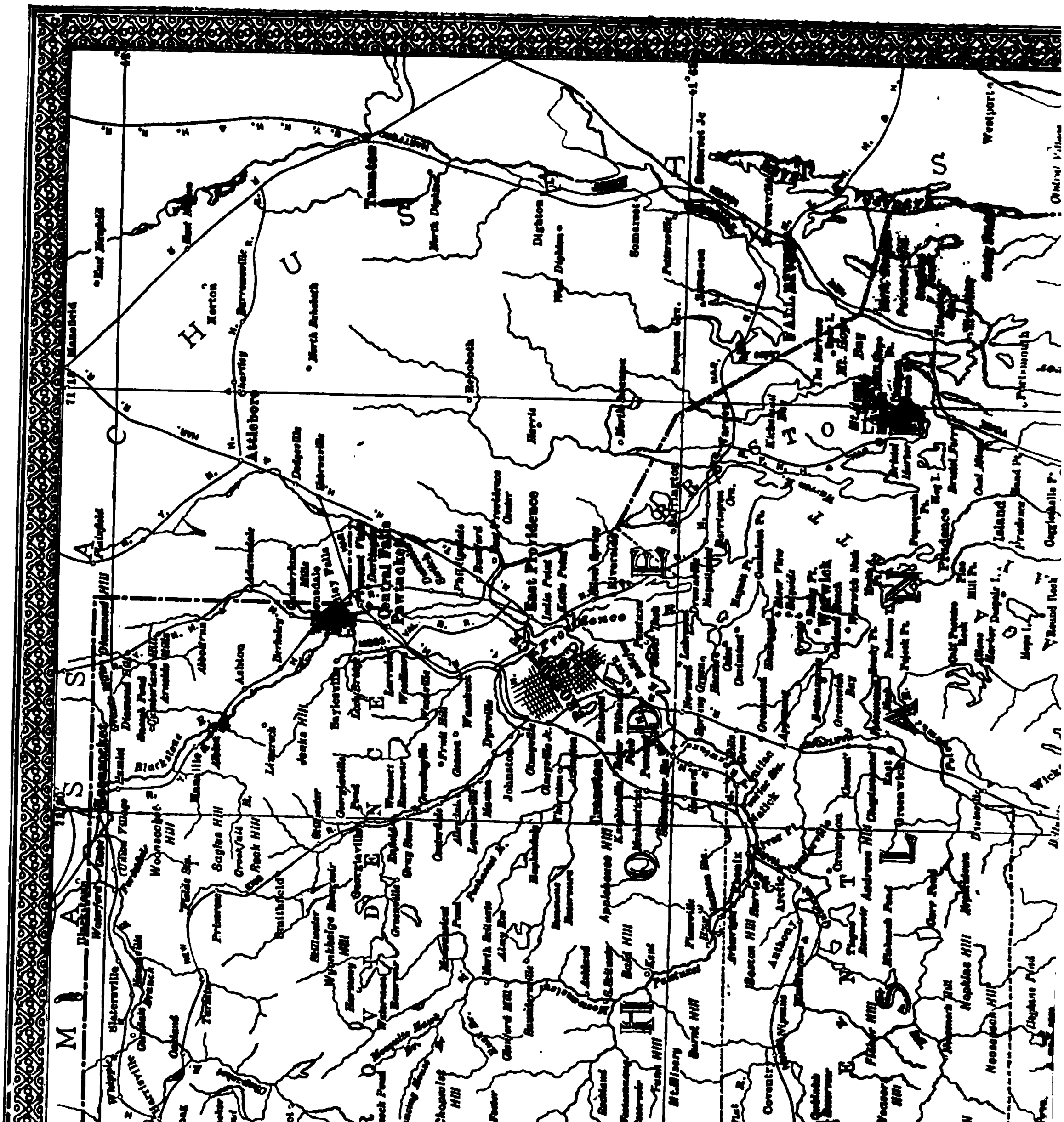
Rhio, rē'ō, or **Riouw,** rē-ow', a seaport belonging to the Dutch, in the Indian Archipelago, on the islet of Tandjong Pinang, in a bay on the south side of the Island of Bintang, 50 miles southeast of Singapore. It is the capital of a Dutch residency, comprising the Rhio Archipelago, the Linga group, and the Tambelan, Anambas, and Natuna Islands, as well as the districts of Kampar, Siak, and Indragiri, on the east coast of Sumatra. The population of the residency is estimated at 108,000.

Rhi'zome, or Rootstock, in botany, a sort of stem found in herbaceous perennials, running along the surface of the ground, or partially or wholly subterranean, sending forth shoots at its upper end and decaying at the other. It occurs in the ferns, iris, etc.; and in the ferns it may be wholly covered with the soil. In the mints, the sand-sedge, couch-grass, and other plants the rhizome is long and slender, but in Solomon's Seal, iris, birthroot, etc., it is stouter. Unlike roots, rhizomes bear scaly leaves at the nodes, and they also send down fibrous roots. The stouter rhizomes may act as storehouses of food.

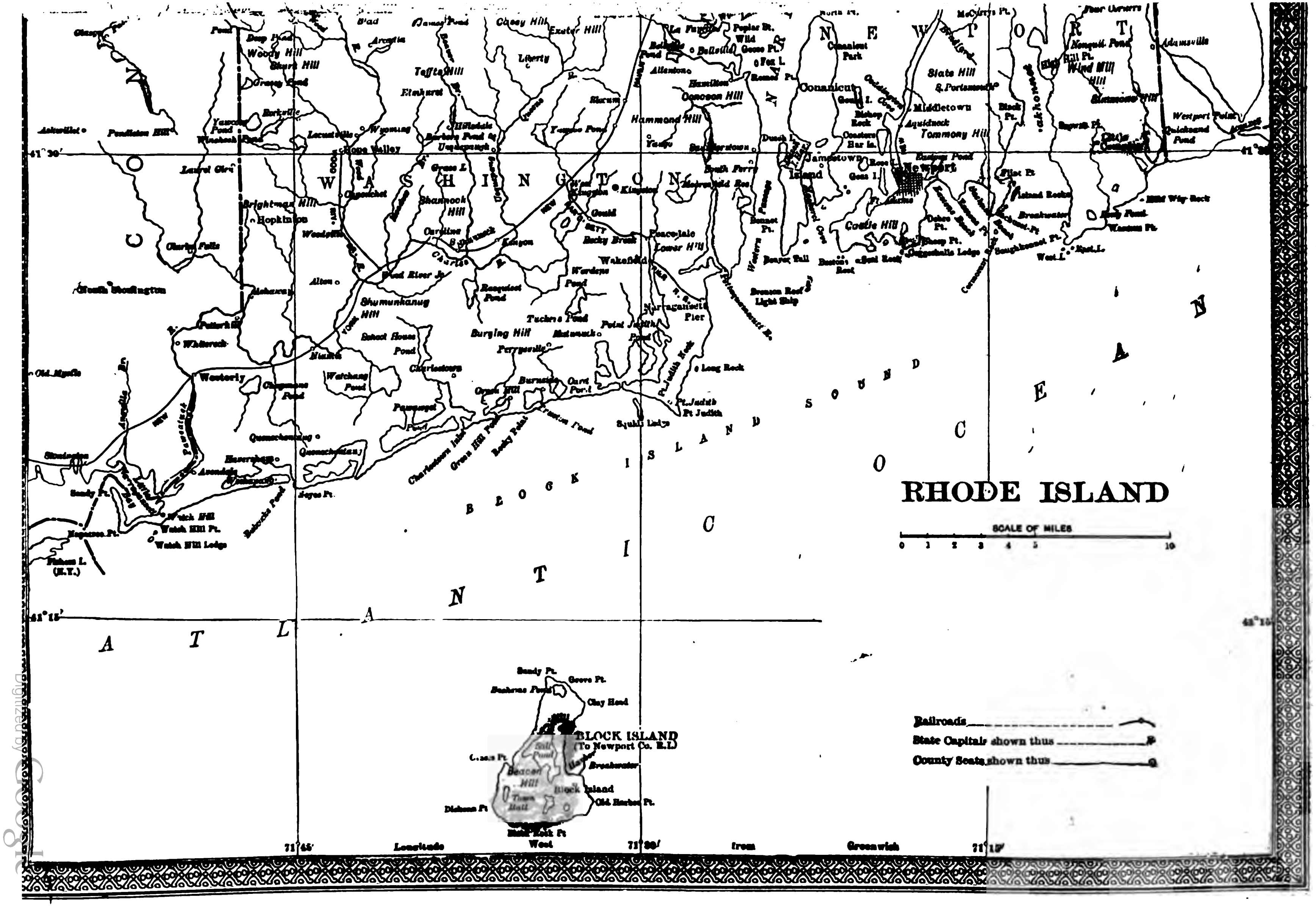
Rhode Island and Providence Plantations, one of the New England States, situated between lat. 41° 18' and 42° 3' N., and between long. 71° 8' and 71° 53' W.: bounded on the north and east by Massachusetts, on the south by the Atlantic Ocean, and on the west by Connecticut. The extreme length of the State from north to south is 48 miles, and the extreme width from east to west is 36 miles. The area is 1,250 square miles, of which 1,053 square miles, including the islands, are land surface. The larger part of the State is hilly, but the general elevation is not great; the highest point, Durfee Hill, in the northwest of Providence County, having an altitude of 805 feet. The large inlet known as Narragansett Bay, ranging in width from 12 to 3 miles, and with lesser bays and inlets branching from it, extends 28 miles inland in a northerly direction. It includes a number of islands, Rhode Island, Conanicut, and Prudence Island being the largest. Rhode Island is 15 miles long and about 3 miles wide, and on it is situated the city of Newport, sometimes called the summer capital of the United States. Block Island lies nine miles from the coast. It is a hilly expanse of verdure-clad sand rising boldly from the Atlantic Ocean. The Great Salt Pond which was formerly enclosed within the island is now an open harbor, and other important improvements have been effected, making the island much more accessible and secure for steam and sailing vessels. The rivers of Rhode Island are small, but they supply the water used by great industrial establishments. The Blackstone and the Pawtuxet in the northern part of the State, and Pawcatuck in the south, are the principal streams. Three streams, the Wanasquatucket, Moshassuck, and West River, flow into the inlet known as the Providence River, which was in early times a widespreading estuary, but which is now confined within narrow bounds. All the streams are rapid for the greater part of their course, and on some of them large dams have been built as reservoirs for the mills. These and the natural ponds add greatly to the picturesque effect of the scenery.

Climate.— The climate is mild, as compared with that of the greater part of New England. The mean temperature for January is 36° and for July 76°, and the humidity averages between 80 and 95 per cent throughout the year. The rainfall ranges from 40 inches in the northern part of the State to nearly 50 inches on the coast.

Geography and Minerals.— In the western part of the State the surface is chiefly composed of Archæan rocks, which in some places, as at Rocky Point, jut prominently into the bay. The bed of the bay itself, with its islands, and a large part of both shores, is composed of deposits from the Carboniferous period, but in the great terrestrial disturbances which geology tells us followed that period, the coal strata in the vicinity of Narragansett Bay underwent changes which greatly affected their value for use as fuel. Coal was discovered at Philipsdale, East Providence, some years ago; but the discovery was neglected until the recent high price of coal called attention to the mine as a possible source of local supply. It is claimed that the mine contains good hard coal, and can be worked profitably. A coal mine in Cranston, near Providence, which has been worked at intervals for many years, but never far from the surface, is being improved, and it is asserted that the quality is better the deeper the vein is followed. Excellent granite quarries are worked in different parts of the State, especially at Westerly, whence granite has been supplied for many notable monuments and buildings throughout the United States. Considerable deposits of magnetic iron ore are known to exist along the western edge of the Carboniferous



MASSACHUSETTS
RHODE ISLAND
CONNECTICUT
PROVIDENCE
BRISTOL
KENT
Providence
East Providence
Pawtucket
Central Falls
Woonsocket
Fall River
Taunton
Attleboro
Bristol
Warwick
East Greenwich
Coventry
Scituate
Foster
Glocester
Burrillville
Smithfield
Cumberland
Lincoln
Johnston
Cranston
Killingly
Putnam
Thompson
Plainfield
Sterling


RHODE ISLAND
SCALE OF MILES
0 1 2 3 4 5 10
Railroads
State Capitals shown thus
County Seats shown thus
41° 30′
41° 15′
71° 45′
Longitude
West
71° 30′
from
Greenwich
71° 15′
N E W P O R T
W A S H I N G T O N
A T L A N T I C
O C E A N
B L O C K I S L A N D S O U N D
BLOCK ISLAND
(To Newport Co. R.I.)
Block Island
Beacon Hill
Town Hall
Salt Pond
Sandy Pt.
Grove Pt.
Clay Head
Old Harbor Pt.
Dickens Pt.
Newport
Middletown
Tommony Hill
Aquidneck
State Hill
& Portsmouth
Conanicut
Jamestown
Island
Conanicut Park
Beavertail
Brenton Reef Light Ship
Kingston
West Kingston
Wakefield
Peacedale
Narragansett Pier
Pt. Judith
Hammond Hill
Oconeon Hill
Saunderstown
Tower Hill
Allenton
Hamilton
Liberty
Exeter Hill
Tefft Hill
Hope Valley
Wyoming
Locustville
Hopkinton
Brightman Hill
Woodville
Shannock Hill
Carolina
Kenyon
Wood River Jc.
Alton
Shumunkanuc Hill
Charlestown
Burying Hill
Perryville
Tuckers Pond
Westerly
Watch Hill
Watch Hill Pt.
Watch Hill Lodge
Pawcatuck
Ashaway
Potter Hill
White Rock
Laurel Glen
Charles Falls
Pendleton Hill
North Stonington
Stonington
Sandy Pt.
Napatree Pt.
Fishers I.
(N.Y.)
Old Mystic
Woody Hill
Deep Pond
Adamsville
Westport Point
Quicksand Pond
Wind Mill Hill
Nonquit Pond
Long Rock
Squid Ledge
Charlestown Beach
Green Hill Pond
Trustom Pond
Quonochontaug
Misquamicut

strata, and limestone is abundant in some parts of the State.

Agriculture.— Farming has not kept pace with other Rhode Island industries, the number of acres included in farms having decreased 17.8 per cent from 1850 to 1900, and 6 per cent 1900 to 1910. Much of this land taken from farms has become sites for factories and villages, or been added to the suburbs of growing cities and towns. The average size of farms has decreased from 103 acres in 1850 to 85 in 1910, while the improved land of farms in 1910 is but a little more than one half as large as the improved area in 1850. This is due in some degree, doubtless, to the fact that many farms are occupied by persons who do not depend on them for a living, and do not cultivate their land to any extent. Farmers who do get a living from their land generally keep cows, and from these derive much, if not most of their income, and this accounts for the fact that hay and forage form the most important crop, occupying 68,000 acres in 1909, while corn amounted to only about 8,000 acres, and potatoes in 1909 to 6,000 acres. Cranston has probably the largest market-garden in the United States, and farmers raise considerable quantities of vegetables for the local markets, while fruit-raising is receiving increased attention.

The number of dairy cows kept is very large, being about 23,316, while the number of sheep has diminished from 11,400 in 1890 to 6,789 in 1910, owing to the increasing difficulty of keeping sheep where dogs are numerous, as in the vicinity of factory towns, and also because their care on a small scale in the East is no longer a sufficiently profitable occupation in competition with the large flocks of the West.

Fisheries.— Oysters, scup, menhaden, and squeteaque are the most important products of the Rhode Island fisheries, which employ about 1,700 persons, and approach in value one million dollars annually. The fisheries of Narragansett Bay were menaced for a number of years by the pollution of the upper part of the bay with the sewage from Providence. This evil has been greatly alleviated, if not altogether removed, as a result of the methods of clarifying sewage recently adopted.

Manufactures.— Manufacturing is the leading industry of Rhode Island, which ranked second in 1900 in the production of cotton goods, and third in the manufacture of woolens, which last-named industry is giving way to worsted and knit goods, in which large fortunes have been made by manufacturers who had the discernment to note the change in popular taste.

Rhode Island is the parent State of cotton-spinning in America. English laws forbade anyone making a model or drawing of English cotton machinery, and sending it out of the country. Samuel Slater, an apprentice to cotton-spinning under Strutt, partner of Arkwright, the great inventor of spinning machinery, mastered the improvements on which he was employed, and came to the United States. Moses Brown invited him to Rhode Island. Slater went, and with the aid of Moses Brown's wealth he succeeded in producing by the close of 1790, at Pawtucket, R. I., cotton-yarn equal to the best made in England. Cotton-spinning became a great Rhode Island industry, and continued to be the leading industry until the attention of manufacturers was turned largely to woolens and worsteds. In 1900 the number of cotton spindles in the State was 1,920,522. The dyeing and finishing of textiles, the silk and silk goods industry, and the manufacture of rubber boots and shoes, and of electrical apparatus are also among the important and growing industries of the State. In the manufacture of the cheaper quality of jewelry Rhode Island stands first in the United States. In solid silverware the State has no superior. The iron industries are flourishing, and include locomotives, Corliss engines, screws — the gimlet-pointed screw being a Rhode Island invention — and all varieties of metal tools. The number of persons engaged as wage-earners in manufacturing in 1909 was 112,565, of whom over 25,000 were women, and over 5,000 children under 16 years of age.

Banks.— The Providence Bank, founded in 1791, is the oldest Rhode Island bank. The Providence Institution for Savings dates from 1819. The banking institutions of Rhode Island (1910) were 22 national, 3 state banks, and 18 savings banks. The national banks had a total capital, according to the report of the Comptroller of the Currency for the year ending September 1, 1910, of $6,700,250; surplus, $3,868,625; undivided profits, $2,421,737; unpaid dividends, $7,663; individual deposits, $27,739,082. The state banks had capital of $375,000; undivided profits, $28,829; deposits, $2,188,926. The savings banks had surplus, $3,748,477; reserve for taxes, $41,557; due to banks, $2,780; deposits, $72,334,583. A very large share of the banking business is in the hands of trust companies, with large capital and surplus. Since the liquidation of several banks carried down in the failure of A. & W. Sprague, 30 years ago, no suspicion has been attached to the solvency of Rhode Island financial institutions.

Railways.—The New York, New Haven & Hartford Railway controls the more important steam lines within the limits of the State, and the railway mileage was 209 miles in 1900. After many years of controversy over location and terms for the disposal of the Cove lands, a Union Station was erected in the city of Providence which added greatly to the convenience of travel in the State. A complete system of electric lines extends throughout the State.

Commerce.—The export commerce from Rhode Island ports is insignificant. Foreign imports at the port of Providence for the year ending 30 June 1909, amounted in value to $1,569,484, and there are customs districts also at Newport, Bristol, and Warren. Congress has made liberal appropriations for the improvement of harbor facilities at Block Island. The wharves at Providence and other ports which once gave room to Indiamen, whalers, and privateers now accommodate steamers and other vessels used in the coastwise trade and summer travel. The boat-building industry of Bristol is known the world over on account of the Herreshoffs, who have constructed several successful defenders of the America's Cup. Narragansett Bay has become a pleasure resort from Providence River to Newport in the east and Point Judith in the west, and in this way a large amount of money is brought into the State while wealthy men from New York and else where, with summer homes in Rhode Island, have selected the State as their legal residence, and pay personal taxes there.

Finance.— Since the State recovered from the financial disorder occasioned by the War for Independence its credit has always been of the highest, and its obligations promptly met. The construction of the new State House at Providence, and other improvements due to the growing needs of the commonwealth have led to extraordinary expenditures within recent years ($2,552,124 in 1910), and on 31 December 1910 the net indebtedness was $4,051,094.20.

Population.— Rhode Island was the most densely inhabited State of the Union by the census of 1900, which gave 428,556 as the total population, or 407 inhabitants to the square mile. The population in 1890 was 345,506. The percentage of foreign population, that is, of residents of foreign birth, naturalized and unnaturalized, is very large, the total in 1900 being 134,509. The foreign element is chiefly of English, Irish, and Canadian origin, but the number of Swedes, Italians, and Russian Hebrews is increasing. The population (1910 Census) was 542,610.

Education.— Rhode Island has excellent public schools, supported by local taxation, and administered by local authority, and under the general supervision of a commissioner of schools. Education is compulsory, and while there is much illiteracy among certain classes of foreigners, parents, almost without exception, show eagerness to have their children educated. In 1908 the school population of the State was 102,084, of whom 78,410 were enrolled in schools. The large majority of teachers are females, the male teachers numbering only 195 out of the 2,314 employed in the schools in 1908, and the average monthly salaries are about $115 for males and $50 for females, the difference being due to the fact that the males are usually in the more responsible places. The State Normal School at Providence is a handsome building, and the State also maintains a College of Agriculture and the Mechanical Arts. The leading educational institution of the State, and one of the best in the United States, is Brown University (q.v.). A private corporation in the State is having constructed a school-ship called "Young America," to give Rhode Island boys and such others as desire it a first-class nautical and preparatory education. The Rhode Island School of Design furnishes educational advantages in the arts of the highest order.

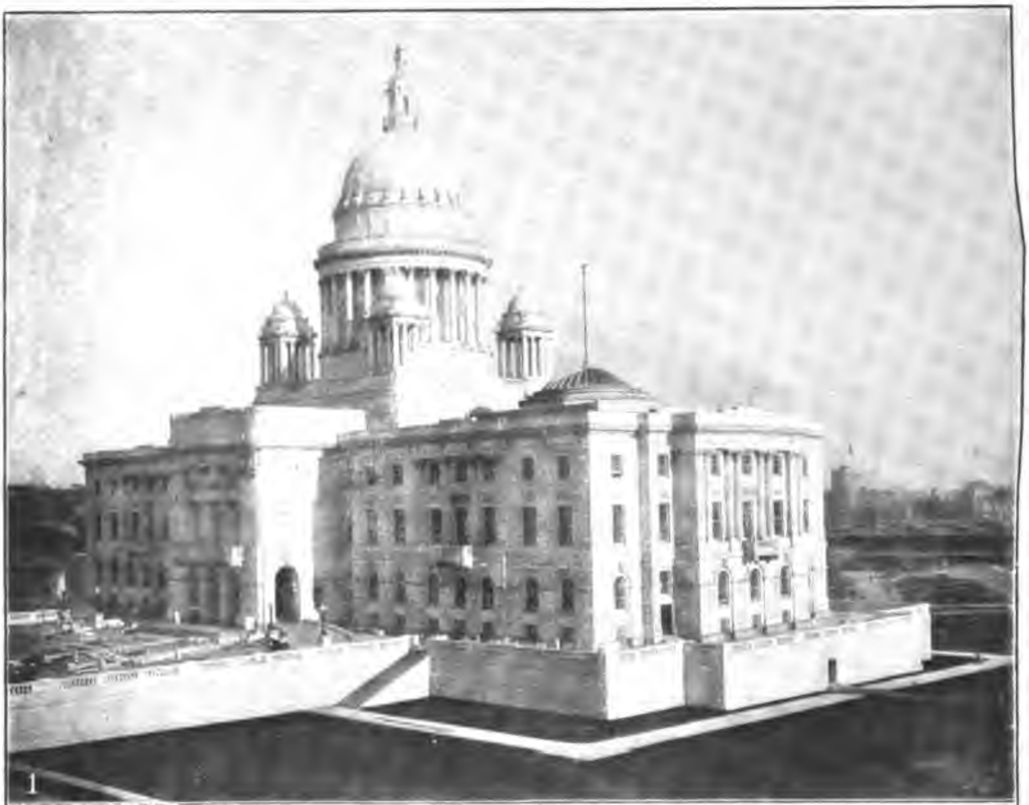
Religion.—The First Baptist Church of Providence, said to be the first in America, dates back to 16 March 1639. Roger Williams was one of its organizers. The Quakers were among the early settlers, seeking refuge from persecution in Massachusetts, and the Friends' School at Providence is one of Rhode Island's best-known educational institutions. The Congregationalists did not venture into Rhode Island until 1721, and while their proposal to come there was received with some bitterness by the descendants of those whom their ancestors had driven into the wilderness, they have become one of the leading denominations in the State. While Roman Catholics were as free to worship in Rhode Island as members of any other creed, it was not until 1813 or 1814 that mass was publicly celebrated in the city of Providence, and the Church of Saints Peter and Paul was completed in 1838. The present handsome Cathedral stands partly on the site of the old church, and the Roman Catholic faith now includes one fourth the population of the State. The Baptists have almost one third of the total Protestant church membership, and the Episcopalians, who celebrated in 1872 the 150th anniversary of old St. John's Church at Providence, have about one fifth. The Methodists date back in Rhode Island to 1787, and have a large membership and prosperous churches. The Universalists settled in Providence in 1772, and have since had a prominent share in the religious life of the State, besides having been instrumental in fostering many important public charities. The Presbyterians are increasing in numbers, and have flourishing places of worship. Rhode Island contains its proportion of other sects and creeds, including the Jews, who were among the early settlers of Newport, where some of them achieved eminence.

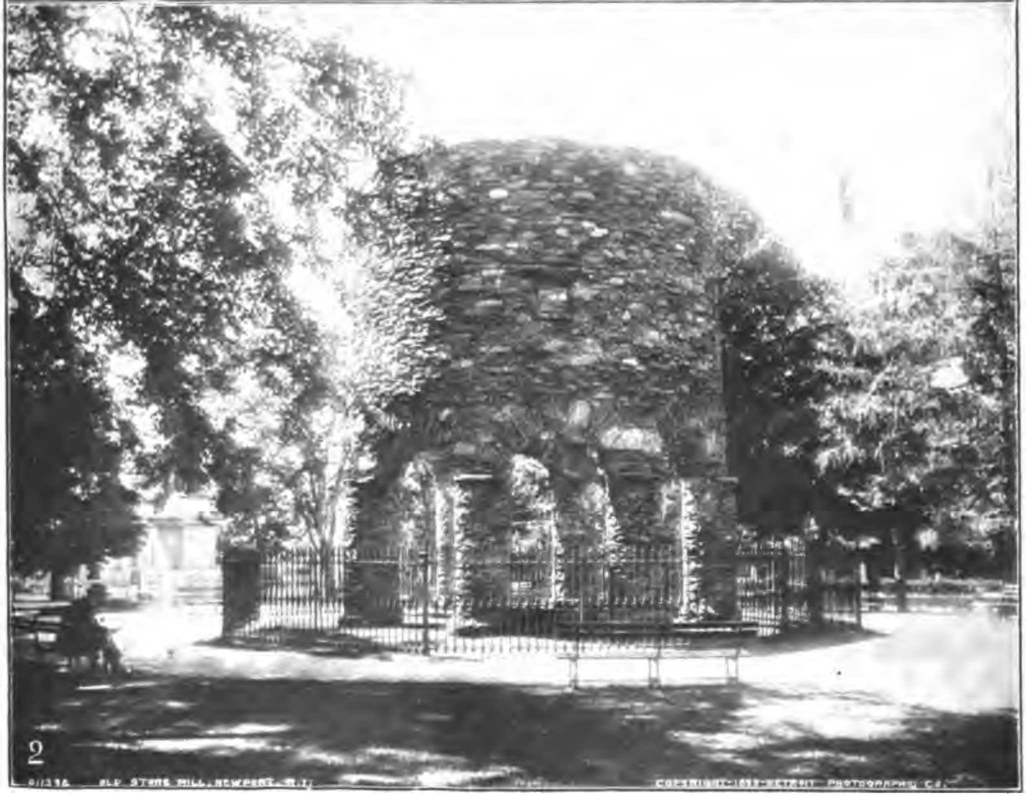
State Government.—There are 33 towns and 5 cities within the State. The governor is elected for one year, and a lieutenant-governor, secretary of State and other State officers are elected for the same period. The governor presides over the Senate, has no veto power, and can pardon criminals by and with the advice and consent of the Senate. The members of the legislature, known officially as the General Assembly, are elected for one year. In the upper house, called the Senate, there is one senator from each city and town. In the lower house, or House of Representatives, every town, no matter how small, has at least one member, but as no town or city can have more than one sixth of the 72 members to which the house is limited, the representation is not proportionate to population. Members of the General Assembly are paid for actual attendance, with a maximum limit of 60 days. The House alone has the power to impeach, and the Senate tries cases of impeachment.

The judicial power is vested in the Supreme Court, and in such inferior courts as the General Assembly may from time to time establish. Preliminary examination of persons charged with serious crimes, and trials for minor offenses are held in the district courts, the justices of which are chosen by the General Assembly. The justices of the Supreme Court are elected by the General Assembly in grand committee, and continue in office until their positions are declared vacant by a resolution of the General Assembly. In practice this has meant election for life, or until retirement by voluntary resignation.

History.—The colony originally consisted, as the name indicates, of more than one community of independent origin, but to Roger Williams, the founder of Providence Plantations, history accords the distinction of having established the commonwealth. Providence Plantations was founded in 1636 by Roger Williams, who fled with several companions from Puritan persecution. He was of Welsh origin, and of respectable family, and his arrival in Massachusetts, 5 Feb. 1631, is recorded as "the coming of a godly minister." Williams soon showed that he had no sympathy with the Massachusetts principle of controlling through the civil government the consciences of men, and he frankly

RHODE ISLAND.

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OLD STONE MILL, NEWPORT, R.I.
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1. The State House, Providence. 2. The Old Stone Mill, Newport

avowed his views in this regard. He thus incurred the censure of the Puritan magistrates and it was at first resolved to expel him from the colonial bounds, and when it was learned that he proposed to found another colony, it was determined to send him back to England. Williams received timely warning of this intention, and he fled into the wilderness with several companions, and at the opening of spring in 1636 he began to plant on the east side of the Seekouk River. He had five companions, William Harris, John Smith, Francis Wickes, Thomas Angell, and Joshua Verin. Here he was not allowed to rest, being notified by Plymouth Colony that the place was within their jurisdiction. Some time between the end of April and the latter part of June 1636, according to excellent authority, he proceeded around what is now Fox Point and up Providence River, landing at the site of the future town, and here he selected a dwelling-place for himself and his associates. His object, as set forth by himself, was "the settling of the plantation, and especially for the receiving of such as were troubled elsewhere about the worship of God." How faithfully that object was carried out Judge Story related in an address on Rhode Island delivered many years afterward. "In her code of laws," he said, "we read for the first time since Christianity ascended the throne of the Cæsars that conscience should be free, that men should not be punished for worshipping God as they were persuaded. He required a declaration which to the honor of Rhode Island she has never departed from."

The settlement on Rhode Island was at first a separate colony, but it also owed its origin to the example and advice of Roger Williams. John Clark and others of Boston went to Providence in 1638 in search of an asylum where they might enjoy liberty of conscience. Roger Williams advised them to purchase from the Indians the large island on the east side of Narragansett Bay, called by the Dutch "Roode Eylandt." This was done, and the adventurers, 18 in number, incorporated themselves as a body politic and elected William Coddington their chief magistrate. A third settlement was formed at Warwick in 1643 by a party of whom John Greene and Samuel Gorton were leaders.

Roger Williams perceived that the union of the weak settlements and the protection of the home government were necessary for their protection from the hostile and comparatively powerful Puritans, and in 1643 he went to England, and brought back in the following year a charter which united the settlements of Providence and Rhode Island under one administration, the name of the colony being Rhode Island and Providence Plantations. The new government went into operation in 1647, when the freemen of the several plantations met at Portsmouth, 19 May, and adopted laws for carrying on the civil government. This charter was confirmed by Cromwell in 1655, and in 1663 Charles II. granted the celebrated charter which remained for 180 years the supreme law of Rhode Island, both as colony and State, and gave place to a State Constitution in 1843 only after the civil convulsion known as the Dorr Rebellion gave notice that the people were determined upon a change. This charter fully recognized the principle of freedom of conscience which was the cornerstone of the commonwealth.

The colony suffered greatly in the war with King Philip. Providence was burned, and the outer settlements were laid waste, and settlers murdered. The Great Swamp Fight, on Rhode Island soil, broke the power of the hostile Indian confederacy, and when King Philip was slain by treachery in the fastnesses of Mount Hope, the red men ceased to be a menace to the security of the settlements.

When Sir Edmund Andros was made governor of New England by James II. he sought to take away the colonial charters, and in 1687 attempted to seize that of Rhode Island, but in some mysterious manner it disappeared and was not found until the accession of William and Mary in 1689. Roger Williams had died in 1683. Notwithstanding the harsh treatment he had received from the authorities of Massachusetts he was ever ready to use his influence with the Indians in behalf of the colonies, and he was instrumental in disarming Indian hostility at times when the colonists were ill-prepared for defense. Although a strong controversialist, and bold and unsparing in his denunciation of those with whom he did not agree, he had a remarkable faculty of commanding the affection and esteem of men, as was signally shown in his ability to obtain for his colony the protection alike of Cromwell and of Charles II. He was exemplary in his private life, and altogether worthy of the reverence which posterity, without regard to creed, attaches to the memory of him whom Whittier has truly called "soul-freedom's brave confessor." He imprinted on Rhode Island a character which it has never lost, and which has been handed down through all the varying changes of population, of liberality and tolerance, of the Sermon on the Mount interpreted in the ordinary every-day actions of men.

The colony grew with a steady and wholesome growth, and religion flourished, although unsupported by the compulsory contributions of worshippers. The people were engaged in agriculture and commerce, and, in times of war, in privateering. During the struggle between Great Britain and France for empire in North America, Rhode Island took an active share in supplying troops and seamen, and the colony had 50 privateer vessels, manned by 1,500 sailors, at sea in 1756. The passion for privateering, with its excitement, its tests of courage and endurance, and prospects of rich reward, became so strong that when Esek Hopkins was commander-in-chief of the Continental navy, with his vessels at Providence, he found it impossible to man them, owing to the fact that privateering offered better inducements. The coast of the colony was infested with pirates in the early part of the 18th century, and some 30 of these ocean highwaymen were hanged at one time at Newport.

It was difficult in earlier years to obtain men to fill the minor public places, and laws were passed which remained on the statute-books for many years, providing penalties for refusal to accept office. This modesty on the part of the forefathers is easier to understand in view of the fact that the expenses of the town of Providence at the outbreak of the Revolution did not exceed $1,000 a year.

The people of Rhode Island were among the foremost in defending American rights against the aggressions of George III. and his ministers. In June 1772 a band of volunteers commanded by Abraham Whipple, who had distinguished himself as captain of a privateer in the wars against the French, burned the British revenue schooner Gaspee in Narragansett Bay. During the greater part of the War of Independence Newport was occupied by the British, and on 29 Aug. 1778 a severe engagement was fought between the Americans, under Sullivan, and the British at Butt's Hill, R. I., in which the British suffered the greater loss.

Rhode Island was the last of the States to ratify the Federal Constitution, its assent not having been given until 29 May 1790, more than a year after the National government had gone into operation. As a small State Rhode Island was peculiarly jealous of its rights, and was slow to assent to its adoption. As the Constitution was first formulated and adopted by some of the original States there was room for a well grounded fear that the smaller States might be destroyed and absorbed through combinations of their more powerful neighbors. It was this fear mainly that caused Rhode Island to stand aloof from the combination, and it was not until that fear had been allayed by amendment to the original instrument that its adoption by the State was effected.

For some years after the Revolution the shipping of the State, being free from British restriction, became known in all parts of the globe then visited by vessels, and the foundations were laid of large fortunes afterward invested in manufacturing, when the shipping business declined. This change took place early in the 19th century, when New England's foreign commerce was practically ruined by the embargo, and when, on the other hand, the War of 1812 gave an impulse to domestic manufactures. Factories were established on every stream that afforded water-power, and Rhode Island grew in prosperity with her expanding industries.

The charter of Charles II., which continued to be the fundamental law of the State, restricted the right of suffrage to freeholders having an estate worth $134, or renting for $7 a year, and to their eldest sons. This was the cause of many wrongs, and of widespread popular protest. It was not uncommon for persons holding mortgages to threaten to foreclose them in order to influence votes, and the system gave rise to much intimidation and corruption. The conservative element strongly opposed a change, and when attempts to obtain reform through the regular course of legislation failed, representatives of the suffrage reform party met in convention and framed a constitution. They claimed that this constitution had been adopted by a majority of the adult male citizens of the State, and it was also alleged that a majority of those entitled to vote under the King Charles charter had voted in favor of the constitution. State officers and a legislature were chosen under this constitution, and organized with Thomas W. Dorr as governor. The charter officials, under Governor Samuel W. King, ignored the Dorr legislature and its enactments, and Governor King, at the head of a military force, dispersed the so-called insurgents. Dorr was convicted of treason, and sentenced to imprisonment for life, but he was released some years later, and his sentence ordered expunged from the records of the State. A new constitution was adopted in regular form, and went into effect in May 1843. It retained the real estate qualification for foreign-born citizens, and this was not abolished until 1888. Another important change adopted within recent years was that permitting election by a plurality vote. This came into effect in 1893. When a majority was required the election was often thrown into the General Assembly, which sometimes chose a minority candidate. Until 1900 the State had two seats of government, the organization of the State government and one session of the legislature being held at Newport in May. Now all sessions are held in Providence, in the splendid new State Capitol.

As a manufacturing State, Rhode Island has been largely influenced by tariff interests in its attitude on National elections, and since 1856 it has always given its electoral vote to the Republican candidates. The Democrats have been successful several times within the past two decades, however, in electing their candidates for governor, and the present Governor, Lucius F. C. Garvin, is a Democrat. Rhode Island has adopted the so-called Australian ballot system of secret voting.

Political power is unequally divided. Each city and town, no matter how large or small, has but one representative in the Senate, or upper branch of the General Assembly, and the representation is also disproportionate in the lower branch. The city of Providence, with nearly one half the population of the State, and contributing nearly one half of the State taxes on general property, elects only about one eighth of the State legislature. In this respect Rhode Island is a miniature of the National government. It is also a singular fact that in Rhode Island's civil conflict, the Dorr "war," the northern part of the State chiefly supported one side, the Dorrites, and the southern part stood by the Charter.

In the Civil War Rhode Island supplied more than its quota to the National armies. General Ambrose E. Burnside, for a time in command of the Army of the Potomac, and whose equestrian statue is a conspicuous feature of the city of Providence, joined the service from this State, of which, however, he was not a native, and later was honored by its people by being elected governor and United States Senator. Rhode Island spared no expense in sending troops to the front, and since that great conflict has been generous in caring for her disabled and dependent defenders. The Soldiers' Monument opposite the City Hall in Providence (now about to be re-located), one of the finest in the United States, bears the names of the gallant dead who fell in defense of their country. In the Spanish-American War also, and the conflict in the Philippines, Rhode Island has been well represented.

EDWARD FIELD,
Author of the 'History of Rhode Island.'

Rhode Island, an island belonging to the State of Rhode Island; at the entrance to Narragansett Bay. It is separated from the mainland on the west by the estuary, Sakonnet River, and is the largest island in the bay. The State was named after this island. It is about 15 miles from north to south and three and one half miles wide. It is divided into three townships: Newport, Portsmouth, and Middletown. It is a famous summer resort. Newport (q.v.), the city, is on the southwest coast.

Rhode Island, Battle of, an engagement which occurred 29 Aug. 1778. The British had seized Newport and garrisoned it with 6,000 men under Pigott. An attack was concerted by Sullivan and Lafayette on land and Count d'Estaing on sea. Sullivan seized Butts' Hill on the island of Rhode Island. Estaing was obliged to meet Howe and the English fleet, but battle was prevented by a fierce storm, and Estaing withdrew to Boston to refit. Pigott attempted (29 August) to carry Butts' Hill, and a bloody repulse of the British resulted; but on the arrival of Clinton with 5,000 reinforcements the Americans were compelled to evacuate the position.

Rhodes, rōdz, **Cecil John,** South African financier and statesman: b. Bishop's Stortford, Hertfordshire, England, 5 July 1853; d. Cape Town 26 March 1902. He was educated at the grammar school of his native town, but before he could pass on to the university, a serious affection of the lungs necessitated his departure for Natal, where an elder brother of his was engaged in cotton-raising. Rhodes landed in South Africa in 1870 and after a brief experience in farming made his way to the diamond fields of Kimberley, where he met with speedy and astonishing success. At 19 he was a millionaire and, with his health well recovered in the salubrious air of the veldt, he planned to return to England to resume his interrupted education. Before leaving South Africa he traveled for eight months, by ox-cart and on foot through the region north of the Orange and the Vaal, and his imagination, which even at that early age worked in vast spaces, saw in the fertile, thinly populated country, virgin soil for the building up of an imperial Britain in the Dark Continent. He matriculated at Baliol College, Oxford, in 1873, but his ailment returned and he was compelled to leave England in the same year. Three years in South Africa made him robust again and from 1876 on he kept his terms at the university, spending the long vacation in South Africa, and taking his B.A. and M.A. in 1881. In the same year Rhodes entered the Cape Parliament as member for Barkly West. By this time his plans for the future had assumed a definite character. Convinced, at all times, of the supreme fitness of the English race for the task of governing the world, Rhodes made it his object in life to further the realization of that end in his own especial sphere of South Africa. To aid him in his schemes he looked to money, in whose power he had a tremendous faith, and it is because of the close connection in him of the selfish money-getting instinct and the broad ambition of the statesman that Rhodes remained for many years an enigma to the world. In the Cape Parliament Rhodes devoted himself to the task of establishing harmonious relations between the English inhabitants and the Dutch, for with true insight he recognized that if British influence was to dominate South Africa it must be conditioned by the good-will of the people of Dutch blood. The first step in his scheme of imperial expansion was the acquisition of Bechuanaland as a British protectorate in 1884. For this he labored against the indifference of the home government, which he finally stirred to action by his insistence upon the necessity of securing Bechuanaland as an outlet for the British trade to the north, already threatened by the encroachments of the Transvaal from the east and Germany from the west.

The annexation of Bechuanaland was a victory for Rhodes over Kruger, the astute president of the Transvaal, but the struggle between the two did not end there. When Boer commanders began to cross the Limpopo River, the northern boundary of the Transvaal, about 1887, Rhodes, to cut off their advance in that direction, obtained from Lobengula, king of the Matabele who were masters of the country between the Limpopo and the Zambesi, the exclusive right to search for minerals within his territories, and in 1889 the British South Africa Company was incorporated with almost absolute political and territorial powers over a vast, indefinite tract north of the Limpopo. In 1890 settlers were brought into the country and founded Fort Salisbury in Mashonaland, and at the same time the construction of a railway was begun which, running entirely through British territory, was to connect the new settlements with the Cape. Reading his title to Rhodesia, as the country was soon called, in liberal terms Rhodes (after 1893) extended the operations of the company north of the Zambesi as far as to the southern end of Lake Tanganyika, and though his dream of an «all red» map of Africa had been dissipated by the convention of 1889 with Germany, which allowed that country to stretch a barrier across the continent to the Kongo State, he did not abandon his scheme of a transcontinental telegraph line from north to south and a railway «from Cape to Cairo.» Upon his political projects Rhodes spent vast amounts of money, partly his own, partly the funds of the De Beers Consolidated Mines, a corporation formed by him in 1888 and controlling the entire diamond output of the famous Kimberley mines. Of this company he was managing director.

In 1890 Rhodes became premier of Cape Colony. During his six years of office he gave special attention to his old policy of amalgamation between Dutch and British; he succeeded in winning the confidence of the former by his strong advocacy of full local government for Cape Colony, which he considered quite consistent with, and indeed, essential for, the scheme of imperial federation. It is this belief in a federal union of locally autonomous commonwealths that explains his gift of £10,000 to the funds of the Irish Home Rule party in 1888. In his treatment of the native races of Cape Colony Rhodes maintained the impossibility of granting them equal rights with the white population, but at the same time held it necessary to protect them by law against the temptations of civilization and exploitation by the whites. In Rhodesia a formidable outbreak of the Matabele in 1893 ended, after a bitter conflict, in their utter defeat and the absorption of their territory by the Chartered Company. Successful everywhere, however, Rhodes was destined to fall before his old opponent, Kruger, of the Transvaal. The Jameson raid in 1895 destroyed Rhodes' personal power, although subsequent events fully vindicated his policy. Though the full truth of the Jameson affair may not perhaps be known, it is established that Rhodes, who was a large holder of mines in the Rand, plotted with other leaders of the Uitlanders in Johannesburg for the subversion of the Transvaal government; that a revolution was prepared in Johannesburg, and that Rhodes stationed Captain Jameson with several hundred men of the Rhodesian mounted police on the western border of the Transvaal to cooperate when necessary with the leaders in the mining town; and though it is also established that Jameson invaded the Transvaal without Rhodes' orders, the evil results of that unhappy affair may not unjustly be reckoned up against the premier of Cape Colony who abused the powers of his office to plot the downfall of a nation. (see JAMESON, LEANDER STARR). A committee of the House of Commons acquitted Rhodes of responsibility for the raid, but censured his conduct as minister and director of the Chartered Company. Rhodes resigned the premiership on the last day of 1895 and thenceforth devoted himself to the interests of Rhodesia. A second war with the Matabele in 1896 was terminated by Rhodes' intrepid courage; the building of the trans-continental railway was rapidly pushed forward, and in connection with this undertaking Rhodes visited Europe in 1898–1900, carrying on negotiations with Mr. Chamberlain, the colonial secretary, and with the German emperor. During the Boer war, in its outcome the triumph and realization of his policy, Rhodes was besieged in Kimberley and took part in its defense. His health, however, gave way, and in spite of a trip to Egypt, his old disease finally conquered. In his lifetime Rhodes was the subject of infinite execration, as well as unlimited applause. Looked upon by different men as a statesman or a land grabber, a builder of empires or an unscrupulous speculator, he was all of these and more; and the anomaly of his character may, perhaps, be best explained if he be regarded as a man of great aims who let nothing stand in the way of their achievement.

Rhodes left the bulk of his great fortune for the establishment of a large number of scholarships at Oxford University to be apportioned as follows: Rhodesia, 9; Cape Colony, 12; Natal, 3; Australia, 18; New Zealand, 3; Canada, 6; Newfoundland, 3; Bermuda, 3; United States, 2 for each State and territory; Germany, 15. All but the German scholarships have an annual value of £300, and all but the last were intended to bring about that complete unity of the English speaking race whose destiny it is, Rhodes believed, ultimately to rule the world. Consult «Vindex,» 'Political Life and Speeches of Cecil Rhodes' (1900); «Imperialist,» 'Cecil Rhodes: a Biography and Appreciation' (1897); Hensman, 'Life of Cecil Rhodes' (1902).

Rhodes, James Ford, American historian: b. Cleveland, Ohio, 1 May 1848. He studied at the University of the City of New York and also at Chicago University, his courses being principally confined to history, literature, rhetoric and metaphysics. In 1867 he went to Paris and attended lectures at the Collège de France, following which he pursued a course in metallurgy at the School of Mines in Berlin, and made a tour of inspection through the iron and steel works of Germany and Great Britain. In 1870 he entered his father's iron business in Cleveland and became a member of the firm in 1874. Having acquired sufficient wealth to enable him to adopt a literary career, he retired from business in 1885, and began the preparation of his 'History of the United States from the Compromise of 1850.' In 1891 he took up his residence at Cambridge, Mass., and the next year the first two volumes of his work were published. Five volumes have so far (1905) been published, carrying the work to the close of 1864. The author's design is to continue the history through the year 1885. The Loubat prize was awarded him by the Berlin Academy of Sciences in 1901.

Rhodes, Mosheim, American Lutheran clergyman: b. Williamsburg, Pa., 14 April 1837. He was graduated from the Susquehanna University, Selinsgrove, Pa., in 1861, was ordained to the ministry in that year and has since held charges in Pennsylvania and Ohio. He was president of the General Synod of the Evangelical Lutheran Church in 1885–6 and is an active promoter of religious educational movements. He has written: 'Life Thoughts for Young Men' (1879); 'Throne of Grace' (1887); 'Scriptural Giving' (1898); etc.

Rhodes, an island of Turkey, in the Ægean Sea, near the southwest coast of Asia Minor, from which it is distant about 11 miles. It lies between lat. 35° 52′ and 36° 28′ N., and lon. 27° 40′ and 28° 15′ E., and has an area of some 560 square miles. The island is crossed from north to south by a high mountain range which attains its extreme elevation in the peak of Atairo, the ancient Atabyron, with an altitude of 4,070 feet. Hills of a lower level traverse the island in all directions and are covered with coniferous trees, the considerable remnants of once splendid forests. Along the many mountain streams tropic plants grow in abundance, chief among them myrtles, oleanders and cactus. The soil is fertile and on the hillsides and in the valleys and plains, vines and olives, figs, pomegranates and oranges are grown. Wheat of an excellent quality is also raised, but not in sufficient quantities to form a commodity of export. Rhodes has been famous since ancient times for the mildness of its climate and its salubrious air. The winds show little variation. The value of the foreign commerce is about $1,000,000, the chief articles of export being sponges, oil and fruit. The island forms a *savjak* or district of the Turkish province of the Isles of the White Sea, and its capital Rhodes (q.v.) is the seat of a pasha. The population is placed at 30,000 of whom two thirds are Greeks, about 7,000 Mohammedans and 2,500 Jews.

The original inhabitants of Rhodes are to us unknown but at the dawn of history we first find the island inhabited by a mixture of races from Asia Minor, and Phœnicians, the latter of whom seem to have come from Crete. In the earliest period of Hellenic migrations Rhodes was overrun by the Dorians who founded the cities of Lindus, Ialysus and Kamyrus, the sites of which may still be identified. These cities with the three Dorian cities on the mainland, Cos, Cnidus and Halicarnassus, constituted the so-called Dorian Hexapolis whose common shrine was the temple of Apollo Triopis on the Carian coast. The sun-god was at all times the favorite deity of the island and from one of his most common emblems, the rose, its name (*rhodos* in Greek, "rose") is said to be derived. The Rhodians were among the most enterprising traders in the Mediterranean and their colonies were found in Spain, in southern Italy and Sicily, and on the southern coast of Asia Minor. In 408 B.C. the inhabitants of the three ancient towns abandoned their homes and joined to form the new city of Rhodes (q.v.) which from now on was the capital of the island. The foundation of Rhodes exercised a tremendous influence on the development of the trade of the island. In the Peloponnesian war, Rhodes sided with Athens until 412 B.C., when it went over to Sparta. In 394 B.C., however, it returned to the Athenian allegiance. Occupied by the Macedonians during Alexander the Great's lifetime, it revolted after his death and defended its independence with splendid success against Demetrius Poliorcetes in 304 B.C. The island was now at the very height of its power; its commerce attained an unprecedented development and by means of its strong navy it made itself master of a strip of territory on the Asiatic mainland. The Athenian orator Æschines (q.v.) established a noted school of oratory in the city of Rhodes, which also became a great centre for the arts, especially sculpture and one of the leading university towns of the Roman world. Early in the 2d century B.C. Rhodes became an ally of Rome and enjoyed its favors. In 42 B.C. it was plundered by Cassius because it sided with Julius Cæsar, and in 44 A.D. it was united to the province of Asia. In 661 the island was taken by the Arabs, but was recovered by the Byzantines who in 1310 gave it over to the Knights of St. John. The latter held it against the Turks until 1522, when it was taken by Solyman II. In 1851 and 1856 the island suffered from severe earthquakes.

Rhodes, or **Kastro**, a town and the capital of the island of the same name, situated at its northeastern extremity. The modern town is of much smaller extent than the ancient city, but is still of imposing appearance. It is built in the form of an amphitheatre and is surrounded by walls and a ditch dating from the time of its occupation by the Knights of St. John, the memorials of whom constitute the most interesting features of the town. Among these are the hospital, the palace of the grandmaster and the cathedral of St. John, the latter two in a ruinous condition. The streets are tortuous, the most picturesque being the Knights' Street, which has preserved its mediæval appearance. The town has three ports, the one to the north, the central, and the southeast port; of these the central port is the only one practicable, but is in part choked up with sand. Near the harbor in ancient times stood the famous Colossus (q.v.). The population is about 11,500, mostly Turks and Jews.

Rhodes, Colossus of. See COLOSSUS.

Rhodes Scholarships. See RHODES, CECIL JOHN.

Rhodesia, rō-dē'zĭ-a, South Africa, a British possession colonized in the last quarter of the 19th century by the British South African Company, founded by Cecil John Rhodes (q.v.), after whom it is named. It is bounded on the north and northwest by the Kongo Free State, on the west by Portuguese territory and Bechuanaland, on the south by Bechuanaland and the Transvaal, on the east by Portuguese territory and the British Central Africa Protectorate, and on the northeast by German East Africa. Total area, about 750,000 square miles. The river Zambesi, which traverses it from west to east, divides it into the two portions called Southern and Northern Rhodesia. Southern Rhodesia (area 174,728 square miles) consists of the two former districts of Mashonaland, capital, Salisbury, and Matabeleland, capital, Buluwayo. Northern Rhodesia is divided into two parts under separate administrators, namely Northeastern Rhodesia, headquarters, Fort Jameson, and Northwestern Rhodesia, headquarters, Lialui.

The river Limpopo forms the southern boundary, and the Matoppo Hills and their northeastern continuations form the watershed between the basins of the Zambesi and the Limpopo. Of the tributaries flowing north to the Zambesi, the most important are the Shanghani, Umfuli, and Panyame; and of those flowing south to the Limpopo the Bubye, Tuli, Shashi, and Macloutsie. The whole country is a plateau varying in elevation from 3,500 to 5,000 feet above sea-level; and in Southern Rhodesia there are numerous mountain ranges, of which the chief is that of the Matoppo Hills already mentioned, Rhodes' burial-place. Of the individual peaks Mount Hampden near Salisbury, Hartley Hill, Mount Wedza near New Umtali, and Mount Inyanga are the best known. There appear to be no lakes of any importance apart from the great lakes on the frontiers of Northern Rhodesia (Tanganyika, Moero, etc.). The prevailing rock-formations are granite and metamorphic rocks, and rounded, projecting knobs of granite, often of fantastic appearance, form a striking feature in the scenery of many districts. The climate in the higher parts of the country is generally suitable for Europeans, but in the lower swampy parts and some of the river valleys malaria is prevalent, and the tsetse fly commits great ravages among cattle and horses. The area above 3,000 feet in Southern Rhodesia, most of which is adapted for the residence of Europeans, is stated at 100,000 square miles, and above 4,000 feet, where European children can be reared, there are 26,000 square miles. The summer season, from December to April, is characterized by great heat during the day and heavy rains, but during the rest of the year the weather is generally dry and much colder, especially in June and July. At Salisbury the mean July temperature is 57.5° F., the mean January temperature 70.5° F., and the extremes for the year are about 34° and 93°. The annual rainfall is about 33.8 inches, and falls on some 75 days. The soil in many parts is fertile, and the ordinary cereals, vegetables, and fruit-trees of Europe can be grown, in addition to the native crops of rice, tobacco, india-rubber, and cotton. Extensive tracts of land furnish excellent pasture. Gold has been worked in Southern Rhodesia from ancient times, and there are striking remains at Zimbabye (near Victoria) and elsewhere, of the works erected by the early miners. At the present time little, if any, alluvial gold is found, but quartz-reefs are being worked with more or less success in various parts of the country, especially around Gwanda, Buluwayo, Gwelo, Sebakwe, Victoria, Umtali, Mazoe, Salisbury, Hartley Hill, Lo Magonda, Abercorn, and Selukwe. The total output of gold for the year 1900–1 was 106,783 ounces, valued at $1,919,900. Coal, iron, copper, silver, tin, plumbago, and kieselguhr have also been reported, and some of them are being worked. Southern Rhodesia is being rapidly opened up by means of railways, telegraphs, and roads. Buluwayo is in direct railway communication with Cape Town, 1,360 miles, and in 1899 the line from Salisbury to the Portuguese coast at Beira was opened for traffic. A line to connect Salisbury with Buluwayo is rapidly approaching completion, and other subordinate lines have been projected or begun.

The whole of Rhodesia, together with the treeless plain of Barotseland on the northwest, acquired in 1899, is under the administration of the British South Africa Company, which was incorporated by royal charter in 1889. Southern Rhodesia, however, is more directly under the control of the imperial government. The administration is carried on in accordance with the company's charter as amended by order in council of 1894 and 1898. The senior administrator, with headquarters at Salisbury, has an administrative council of six members and a legislative council of ten members, the latter including two elected representatives of each of the two great divisions of the province. The enactments of these councils are subject to the approval of the High Commissioner for South Africa, who acts through a Resident Commissioner. Jury trial was introduced in 1899. There are resident magistrates and judges, from whom an appeal lies to the Supreme Court of Cape Colony, and thence to the Judicial Committee of the Privy Council. Salisbury and Buluwayo have a regular municipal government, and doubtless this will be extended in time to the rising towns of Umtali, Gwelo, Tuli, Tati, Victoria, Wankie, Melsetter, Enkeldoorn, Charter, Gwanda, etc. The revenue in 1901–2 was $2,176,200 and the expenditure $3,552,800. The total native population of Southern Rhodesia is estimated at 510,000. The white population of Southern Rhodesia was about 11,300; of North-eastern Rhodesia, 164.

The chief tribe of original native inhabitants is that of the Mashonas, a peaceful and industrious race. In 1836 a Zulu people, known as Matabele, invaded the country under a chief called Mosilikatse, and easily conquered the indigenous inhabitants. For more than 50 years this warlike race held undisputed sway in Southern Rhodesia, and appear to have grievously oppressed the subject peoples, but in 1890 an expeditionary force equipped by the British South Africa Company occupied Mashonaland without opposition and founded the town of Salisbury. The Matabeles were for a time left undisturbed, but in 1893 their raids into Mashonaland gave the company an opportunity of extending its authority. Three columns, one of them assisted by subjects of Khama, chief of the Bamangwato, advanced from the northeast, the east, and the southwest respectively upon Buluwayo, the capital of Lobengula, who had succeeded his father Mosilikatse as chief of the tribe. The Matabeles were easily overcome by means of the Maxim machine-guns, and fled to the hills. Toward the end of 1893 Lobengula sent overtures for peace, together with a sum of money, but the fatal cupidity of some men of the Bechuanaland police prevented these from reaching the company's officials. Accordingly the Matabeles who remained around the person of their chief, enraged by the supposed rejection of their overtures, surrounded a small party of Englishmen under Major Wilson, who, unable to escape, fought desperately till all were killed. Lobengula died early in 1894, and all resistance was at an end. Matabeleland has since formed a part of the company's dominion, but a serious native revolt, partly due to the ravages of rinderpest and locusts, broke out in 1896. Mashonaland also revolted about the same time, but both rebellions were peaceably settled by Cecil Rhodes' personal influence over the natives. Consult: Bent, 'The Ruined Cities of Mashonaland' (1893); Hall, 'The Ancient Ruins of Rhodesia' (1902); Hensman, 'History of Rhodesia' (1900); Knight, 'Rhodesia of To-day' (1901); Leonard, 'How we made Rhodesia' (1896); Thompson, 'Rhodesia and its Government' (1898); Tort, 'Rhodesia Past and Present' (1897).

Rho'dian Law, an early system of marine law, said to have been compiled by the Rhodians after they had obtained the sovereignty of the sea. The only rule that we know now, though the entire code was adopted by the Romans under Antonius Pius, is the principle of general average: «If a cargo be jettisoned to lighten the ship, all contribute to make good the loss incurred for the benefit of all.» The mediæval naval law of the Rhodians was not of Rhodian origin. It consisted of four distinct parts, of very different dates, but mostly of practical value.

Rho'dium, a metal belonging to the platinum group, discovered by Wollaston in 1804. It occurs in small quantities in various platinum ores; is a grayish-white metal; is very hard and infusible, scarcely softening in the flame of the oxyhydrogen blowpipe; and is unaltered in the air at ordinary temperatures, but oxidizes at a red heat. Insoluble in acids, it is readily oxidized by fusion with nitre. The specific gravity of fused rhodium is 12.1; its atomic weight is 103. The compounds of this metal have not been much studied.

Rhodochrosite, or **Dialogite,** native manganese carbonate. It is usually either cleavable-massive or in rhombohedral crystals of rose-pink or brownish-red color. Its lustre is vitreous to pearly; hardness, 3.5 to 4.5; rhombohedral, cleavage highly perfect. Its most important localities are in Hungary, Germany and Colorado, in which State many magnificent specimens have been found.

Rhododen'dron, a genus of shrubs and trees of the order *Ericaceæ*. About 200 species have been recognized, natives mainly of the cooler parts of the northern hemisphere. They are most numerous in eastern Asia; seven are indigenous to America. They are usually evergreen, have smooth simple leaves, and terminal umbel-like racemes of generally very showy flowers for which the plants are widely popular as ornamentals. A few species yield wood which is used in turning, and cabinet work, but more largely as fuel; the flowers of others are used in jelly-making, and the leaves of a few have been used medicinally. They are sometimes made to include azalea (q.v.) by some botanists, but are usually considered distinct, the azaleas being generally deciduous. Some species are only a few inches tall, others exceed 50 feet in height and 18 inches in diameter.

Rhododendrons are readily propagated by seeds, cuttings or layers usually under glass; but choice varieties are most frequently grafted upon seedling stocks. The seeds are very small and are generally sown in seed-pans during early spring in peaty, sandy soil. The seedlings are pricked off as soon as possible; the greenhouse kinds under glass, the hardy ones in cold frames until the following year, when they may be grown in nursery rows. When planted in the garden they should always be protected from heavy wind, and the full glare of the sun. The deep shade afforded by walls and hedges is, however, not generally desirable. They do not succeed well as a rule upon limestone, limy or clayey soils, but thrive best upon well drained, though moist loamy soils underlaid by porous subsoil. Since the roots lie close to the surface no cultivation can be given, but mulching may take its place. Pine needles, marsh or salt hay are specially desirable since they are free from weed seeds. Annual or biennial dressings of well rotted stable manure should be given. The seed vessels should be cut off when the flowers have fallen, to divert the plant food into new flower buds and to prevent the scattering of seed. The greenhouse kinds require very porous peaty soil, free watering during the summer, careful watering in winter, cold but not frigid quarters for the Himalayan species, and not less than 50° for the Javanese kinds which bloom and grow continuously and require more water also. These last also being epiphytes require still more open soil. They are exceptionally attractive when properly grown.

Among the American species the great laurel (*R. maximum*) is the largest, attaining a height of 30 feet or more. It is indigenous from Nova Scotia to Michigan and southward in the mountains to Georgia. In early summer when its rose or lilac flowers appear in profusion it is an imposing subject and is justly popular as a park specimen. If taken when small from loose soil in the woods it usually transplants well, but nursery-grown plants should be given preference. Though called *maximum*, several of the Asiatic species discovered since this was named are far larger. *R. catawbiense*, a species with lilac-purple flowers often 1½ inches in diameter, is one of the most beautiful of ornamental shrubs. It rarely exceeds 15 feet. In the mountains from Virginia to Georgia it is very common but in cultivation is well known as hardy in New England. It is one of the parents of a host of hybrid varieties of remarkable beauty.

R. ponticum, a native of western Asia and the Iberian peninsula, resembles *R. maximum* but rarely exceeds 10 feet in height. It is considered less hardy than the preceding species, but is widely cultivated, especially in Europe. Several remarkably striking species were discovered by Hooker and other botanists in southern Asia, those of the Khasia Hills being especially noted. Only a few of these, however, have been introduced into cultivation and still fewer have been brought to America. Some have flowers four inches in diameter, others perfumed blossoms, and some are epiphytic in their habits.

Consult Bailey, 'Cyclopedia of American Horticulture' (New York, 1900–2).

Rhodolite, a beautiful light red variety of garnet (see GEMS), found only in North Carolina, highly prized as a gem, for which it has been extensively worked and sold within a few years past. The name is from the Greek *rhodon*, a rose, the color resembling some roses and rhododendrons, and unlike most garnets, becoming extremely brilliant by artificial light. Analysis shows that rhodolite is composed of two molecules of pyrope garnet with one of almandite garnet. It occurs intimately associated with the Cowee rubies (see RUBY) of Macon County, the crystals of the latter sometimes even enclosing the rhodolite. It is one of the most important gem-stones of North Carolina.

Rhodonite, a rose-pink or brownish-red triclinic mineral, essentially a manganese metasilicate, $MnSiO_3$. It usually contains some calcium and iron, while zinc is present in the variety fowlerite, which occurs at Franklin Furnace and Ogdensburg, N. J., in groups of magnificent crystals several inches in length. Sweden yields attractive specimens, and masses of much beauty associated with braunite are found at Cummington, Mass. Its most important occurrence is near Ekaterinburg, in the Ural Mountains, from which locality the Russians have for many years mined considerable quantities as an ornamental and semi-precious stone, for which purposes it is highly esteemed, being cut into pillars, mantels, table tops, jewel caskets, etc. Its hardness varies from 5.5 to 6.5. Crystallized specimens show an eminent cleavage; the massive forms are exceedingly tough, like jade.

Rhodope, rŏd'ō-pē, ancient name of a mountain chain (7,474 feet) extending along the borders of Macedonia and Thrace. The Turks call it Dospad Yailasi, the Bulgarians Despoto Dagh, both titles having reference to the numerous (Greek) monasteries that stud its sides. Of these the most famous is the vast fortress-monastery of Rilo, in the northwest of the range, standing on its south side in the midst of magnificent pine forests. Rilo has for generations been the focus of the national Bulgarian Church and the mainstay of Bulgarian nationality.

Rhondda, rŏnd'da, a river and town of South Wales, in Glamorganshire. Its valley is the seat of a large population engaged in coal-mining and metallurgical industries. The inhabitants are employed mainly in collieries, ironworks, etc.

Rhone, rōn, a river of Europe which rises in Switzerland, near the east frontiers of the canton of Valais. Its precise origin is commonly said to be in the Rhone glacier, between Mount

Furca on the east, the Gallenstock on the north, and the Grimsel on the west, 5,581 feet above the level of the sea; but the natives give the name of Rhodan or Rotten to three springs situated in a single basin at the foot of the Mayenwand, at an elevation of 5,282 feet, the water of which flows with an equal temperature in summer and winter (61° to 63° F.), and these they consider to form the true source of the Rhone. The waters from these springs join the stream from the glacier at a very short distance from their origin. The young river dashes down with great rapidity into the valley beneath, leaping from cascade to cascade; traverses the centre of Valais in a westerly direction, and near Villeneuve enters the Lake of Geneva at its eastern extremity. On entering the lake its waters are surcharged with mud; but on issuing from it, at its southwest extremity, at the town of Geneva, it is of a pure deep blue color, soon after changed into a muddy brown by the accession of the glacier-born Arve, which joins it 1½ miles below Geneva. Proceeding southwest to the frontiers of the department of Ain in France, it turns almost due south, forming the boundary between that department and Savoy; then turning suddenly northwest, traces the boundary between the same department and that of Isère, and reaches Lyons. Here, having at least doubled its volume by the accession of the Saône, it proceeds almost due south, separating the departments of Rhone, Loire, Ardèche, and Gard on the west, from the department of Isère, Drôme, and Vaucluse on the east. On approaching Avignon it takes a more circuitous but still southerly course, separates the department of Gard from that of Bouches-du-Rhône, traverses part of latter department, and finally falls into the Gulf of Lyons in the Mediterranean. At Arles it divides into two branches, the less of which, under the name of old Rhone, flows southwest, forming the west side of the large delta, known by the name of the Ile de Camargue. The main branch, under the name of Grand Rhone, continues its southerly course, but again divides into two branches, and enters the sea by two mouths. Its whole course is about 580 miles, of which 200 miles are in Switzerland, and 380 miles in France. It is navigable for 360 miles. By means of a series of magnificent canals, the navigation of the Rhone has been continued, without interruption, to the Rhine (through the Saone), Seine, Loire, and Garonne.

Rhopalac'eræ, butterflies (q.v.); see also LEPIDOPTERA.

Rhubarb, Wine Plant, or **Pie Plant**, several species of perennial herbs of the genus *Rheum*, order of *Polygonaceæ*. They are natives of Asia and eastern Europe and have generally very large radical leaves with thick fleshy petioles, and small greenish or whitish flowers in racemes or paniculate fascicles which are borne on stout stalks well above the foliage. Several of the species are valued for bold effects in ornamental gardening, and some have been used in medicine, but the most important species is the common rhubarb (*R. rhaponticum*) which has long been cultivated in gardens for its tender, acid, esculent leaf-stalks which are largely used for making pies, sauce, and preserves in spring, and to a less extent for home-made wine from the juice. The plants are usually propagated by means of divided roots, though seed is also used. They thrive best in rich, light, friable loamy soils, well drained but moist, and given liberal applications of manure of all kinds. The plants should be set not less than three feet apart each way, given clean cultivation until the foliage shades the ground, and mulched with stable manure during the winter. When two years old the stalks may be used freely. They are most easily gathered by bending them down while being pulled. The earliest stalks are obtained by inverting a barrel over the plants and heaping manure around it. But for forcing, the roots are dug in autumn, allowed to freeze, covered with earth or sand in cellars, under greenhouse benches, etc., and watered. After producing a crop the roots are thrown away. Large quantities are cultivated in the Southern truck gardens, but the forced stalks are considered superior and generally command higher prices.

Turkey rhubarb, formerly popularly used in medicine, is supposed to be derived from *R. palmatum*, but the exact species seems to be still undetermined. Chinese Tartary and parts of China were the principal shipping countries, but Asia Minor was also a producer.

Rhumb-line, a line described on the earth's surface by a ship sailing steadily in the direction of any one point of the compass, except one of the four cardinal points. A rhumb-line laid down on a map drawn on the principle of Mercator's projection is a straight line cutting the meridians at a constant angle; but if a rhumb-line be drawn on a globe, so that it will cut the meridians all at the same angle, it will be found to be a spiral curve such that however far it may be produced it will always approach the pole, but never reach it.

Rhus, a genus of the cashew-nut family (*Anacardiaceæ*). It is found all around the world, and the species are generally shrubs, with simple or compound leaves, and small five-merous flowers in panicles. The fruit is a dry, one-seeded drupe, often in conspicuous masses. Some, like the American staghorn sumac (*Rhus typhina*), with its tropical appearance and the smoke-tree (*R. cotinus*) are planted for ornament; and the *R. coriaria* is cultivated along the Mediterranean for its leaves, a valuable material for tanning leather, when a fine white color is desired, as in light morocco. The foliage of some other species is also gathered for the same purpose. The American aborigines used *Rhus* berries for red, and the juice for black dyes, and the bark of *R. glabra* is employed as a mordant for red colors. Oriental lacquer is made from juice exuding from incisions in the bark of *R. vernicifera*. Many species, including the *R. toxicodendrom*, which, like *R. vernix*, is poisonous to the touch (see PLANTS, POISONOUS), are used in medicine, and the acid fruits of certain species are made into cooling drinks or sharpened vinegar. Chinese galls are produced by *R. semialata*, and candlewax is expressed from the berries of the wax-tree (*R. succedanea*), and from *R. vernicifera*, often planted in Japan, for that purpose. One or two species furnish a useful wood.

Rhyacolite, a variety of orthoclase, occurring in glassy crystals in the lavas of Vesuvius, Italy.

Rhyme, a stanza in which two or more lines end in a similar sound; also two or more final syllables having the same sound. Since rhyme, in the latter sense, is the most prominent mark of versification to-day, the word is usually understood to refer to the coincident sound at the ends of the verses. Rhyme was used, in a sense which has now become obsolete, to mark similarity of syllabification in other portions of the line than at the end. Thus the old writers speak of rhyming words when they mean words beginning with the same consonant, that is, in alliteration; also, in Spanish and Portuguese what we now call assonance — a coincidence of vowels in corresponding syllables, without regard to the consonants — was also called rhyme. Rhymes of to-day demand agreement in final syllables of the sound of the vowels and the succeeding or interposed consonants, if there are any, with a dissimilarity of preceding consonants, if there are any. Rhymes of such a character are of three kinds in English: single, or of one syllable, as flap and slap; double, or of two syllables, as greeting and fleeting; triple, or of three syllables, as merrily and cheerily. The single rhymes are often called male, and the double, feminine rhymes. The triple rhyme is used, in English, principally in verse of a conversational or comic or facetious nature. Rhymes of more than three syllables are practically unknown in all except the Persian language and its branches. In the perfect rhymes of to-day the preceding consonants, it has been stated, must not be the same; thus, partake and lake make perfect rhymes; but not partake and take, which makes an inelegance to the ear. The final syllables, moreover, of the perfect rhymes must both be accented; thus butterfly will not rhyme with terribly, although the final syllables are suited in other respects for rhyming. There are, however, rhymes which occupy middle ground — permitted by the exigencies of the occasion in which they are used (known as poetic license) — which are not to be tolerated in ordinary occasions or if frequently used. Such rhymes are those that nearly coincide in sound, and which do not offend the ear by failing entirely to do so. Thus gone may be rhymed with alone under poetic license. There is no rule by which a permissible imperfect rhyme may be determined and the only criterion is to be found in good usage as established by the better class of authors. Some languages incline more to the male rhyme, as the English, on account of its superabundance of monosyllables; others, as the Spanish and Italian, more to the female; the German and French possess an almost equal store of both. The female rhymes in French all contain an *e* mute in the last syllable; and from the beginning of the 16th century it has been the almost uniform practice among French poets in dramatic, heroic, elegiac, satirical, and other forms of poetry to make couplets of male rhymes alternate with others of female rhymes. In the ode combinations of rhymes are used, but always regular. When two successive lines rhyme they form a rhymed couplet, the measure used by Pope in his famous 'Essay on Man.' Three successive rhyming lines form a triplet; four a quatrain, but there may be two pairs of rhymes in a quatrain. Rhymes are used throughout poetry in accordance with the author's own taste and inclinations. In some poetry every line is rhymed with some other. And this may be an adjacent line or one separated from its partner by one or more lines which do not end with the same rhyme, but with some other. The position of the rhyming pairs in the stanzas must be the same in each verse of the composition, and, moreover, within the stanzas the rhymes must occur regularly, according to some fixed scheme. In long poems, indeed, it is not infrequently the case that different portions of the poem employ stanzas in which the rhyme schemes differ. This is permissible because, on account of the length of the composition, the effect is the same as if it were composed of several shorter poems.

It is not necessary that every line in the poem should rhyme, and some of the pleasantest effects have been produced by the use of a mixture of rhyming and not-rhyming lines. When rhyme is totally absent poetry is spoken of as blank verse. The rhyme does not always occur only at the end of lines. It sometimes occurs at two places within the line, at the middle and at the end. But this is only a supplementary or secondary rhyme; it is not to be used except in conjunction with lines which have proper or terminal rhymes.

The rhyme scheme employed, in conjunction with the kind of measure used, determines the structural character of poetry (q.v.). The most complex forms now used in English are found in the sonnet (see POETRY) and in the Spenserian stanza, so-called because adopted by Spenser and used in his 'Faerie Queene.' There are a number of artificial forms of verse known as the French forms, because invented and brought to perfection by the poets of that nation, in which the positions of the rhymed lines vary greatly not only in the stanzas, but in the poem as a whole. The most commonly employed of these forms are the triolet, rondel, rondeau, vilanelle, and ballade.

The modern use of rhyme was not known to the ancient Greeks and Romans. We meet, indeed, with some rhymed verses in Ovid, in which the rhyme was evidently intentional; but these examples are rare. It has been used, on the other hand, from time immemorial among the Chinese, Hindus, Arabs, and other oriental nations. Rhyme began to be developed among western nations in the Latin poetry of the Christian Church. It is found used as early as the 4th century, and in subsequent centuries grew to common use in the writings of church officers and ecclesiastical students. The use of rhyme in the vulgar dialects of Latin was even more general than in ecclesiastical poems, as is shown by the poetic monuments of the Romance nations belonging to the 9th and 10th centuries. In the Latin poems of the Fathers of the Church of the 4th century rhymes are more frequently used. The most ancient relics of Teutonic and Scandinavian poetry are not in rhyme, but are distinguished by alliteration. The earliest use of rhyme in a Teutonic dialect is in Otfried's 'Evangely,' written in Frankish, in the latter part of the 9th century. The oldest forms of rhymed verse are the couplet and the continuation of one and the same rhyme through a whole piece. The oldest poems of the Chinese, Indians, Arabians, and of other ancient peoples are rhymed; so are those of the Irish and the

Welsh. In the fragments of the earliest Latin poetry yet found, where the metre is accentual, not quantitative there is a marked tendency toward rhymed endings. This tendency was lost for a time under the influence of Greek poetry in which the measures are quantitative. Still the partiality for rhymes was not lost, as is proven by the verses of Ovid, and upon the decline of classicism (see Romantic) they became common. An attempt at sustained rhymed verses can be found as far back as the 4th century, as evinced in the verses of Hilary. By the end of the Middle Ages rhymed Latin verse had reached its perfection. (See Logoædic Verse.) For a general discussion of rhyme schemes and verse-forms consult G. L. Raymond's 'Rhythm and Harmony in Poetry and Music' (1895); Guest's 'History of English Rhythms' (1838); Parson's 'English Versification'; R. C. Trench's 'Sacred Latin Poetry.'

Rhymer, Thomas, the familiar name of an early Scottish poet, whose real name is supposed to have been Thomas Learmount. He flourished in the latter part of the 13th century at Ercildoune (modern Earlston), Berwick. To this day the name of Thomas the Rhymer is popularly known in Scotland as that of a prophet, who derived his powers from residence in Fairyland; and it is only through the discovery of the manuscript of a metrical romance called 'Sir Tristram' (supposed by Scott to be his work, though this is still a matter of dispute) that he has acquired a better claim to remembrance. A good edition of the 'Tristram' is that of M'Neill (Scottish Text Society, 1886). Consult also Murray's edition of the 'Romance and Prophecies of Thomas of Ercildoune' (Early English Text Society, 1875); Scott's 'Minstrelsy of the Scottish Border' (1806); and Child's 'Popular Ballads' (Pt. ii., 1884).

Rhynchocephala, rĭn-kō-sĕf'ạ-lạ, a suborder of very ancient prosaurian reptiles, fossil chiefly in the Old World Triassic, having much superficial resemblance to lizards, and perhaps in the direct line of ancestry, by way of *Sphenodon* which still survives as a key to the group. They were unarmored, terrestrial, lizard-like creatures, varying in length from a few inches to six or eight feet. Important genera are *Rhynchosaurus, Hyperodapedon, Homœosaurus,* found in Europe and India. The most remarkable genus, however, is *Sphenodon* (or *Hatteria*), one species of which is still living in New Zealand. See Tuatera.

Rhy'olite, a silicious porphyritic rock resembling granite in chemical composition. The name was first given by Richthofen to igneous rocks in Hungary distinguished from trachyte mainly by a more varied texture and the presence of quartz. The western Cordilleras of America, as well as like regions elsewhere, contain rhyolite in vast areas. Rocks of the same or similar structural character are now known also under the names of liparite and nevadite. The rocks which petrographers formerly classed among felsites are now mainly described under the name of rhyolite, which includes a much greater number of varieties.

Rhys, rēs, **Ernest,** English author: b. London 17 July 1859. He was educated at Bishop's Stortford and Newcastle-on-Tyne and in 1877 became a mining engineer. In 1885, however, he turned his entire attention to literature and in 1887 made a lecturing tour in the United States. He was editor of the Camelot series of reprints and translations (65 vols., 1886–91), of 'The Lyric Poets' (12 vols., 1894–9), and other publications and has written: 'The Great Cockney Tragedy' (1891); 'Welsh Ballads and other Poems' (1898); 'Frederick Lord Leighton' (1898); 'The Whistling Maid' (1900); 'Celtic Lore' (1901); 'Ogam-inscribed Stones Preserved in Dublin' (1902); etc.

Rhys, John, Welsh Celtic scholar: b. Ponterwyd, Cardiganshire, 21 June 1840. He was educated at Bangor Normal College for the teaching profession; kept a school in Anglesey till 1865, and in 1869 was graduated from Oxford. Continuing his studies at the Sorbonne and Collège de France in Paris, Heidelberg, Leipsic, and Göttingen, in 1871 he was appointed inspector of schools for Flint and Denbigh, and in 1877 professor of Celtic in Oxford University, becoming in the same year an honorary fellow of Jesus College, of which he has been principal since 1895. He was already known as a Celtic scholar before the publication, in 1877, of his 'Lectures on Welsh Philology' gave him a high reputation in this department of scholarship. Later works are: 'Celtic Britain' (1882); 'Origin and Growth of Religion as illustrated by Celtic Heathendom' (1887); 'Studies in the Arthurian Legend' (1891); 'The Early Ethnology of the British Isles' (1891); 'Inscriptions and Languages of the Northern Picts' (1892); 'Celts and Pre-Celts; The Welsh People' (1900), in collaboration with J. B. Jones; and 'Celtic Folk-lore' (1901). He has also edited various Welsh texts in conjunction with J. G. Evans.

Rhythm, rĭthm, in metrics, the measure of time or movement by means of a numerical proportion or harmony. In prose literature it follows no regular law, but consists in an arrangement of words in an expressive succession. This arrangement may at times approach the regularity observed in rhythm in verse; and the term prose-poetry has been applied to the prose in which such regularity is strongly marked. In poetry, rhythm is reduced to law, and consists in a regular succession of arses and theses (long and short; accented and unaccented syllables). This results in a precise cadence, or variety of cadences; modified, of course, by the pauses necessary to rhetoric. See Phrase.

Rhyti'na. See Sea-cow.

Riall, rī'ạl, Sir **Phineas,** British military officer: b. County Tipperary, Ireland, 15 Dec. 1775; d. Paris, France, 10 Nov. 1850. He entered the British army as ensign in 1794 and became major in the same year. In 1804 he was attached to the 15th Foot, and in 1808–10 commanded a brigade in the West Indies. He was promoted major-general in 1813 and ordered to Canada to participate in the war against the United States. He served on the Niagara frontier and was chief in command in the campaign against General Jacob Broun in the following summer. He was defeated at Chippewa and at Lundy's Lane, being severely wounded and taken prisoner in the latter engagement. He was appointed governor of Grenada in 1816, was knighted in 1833, and in

1841 received full rank as general. Consult: Morgan, 'Sketches of Celebrated Canadians and Persons Connected with Canadian History' (1862).

Rialto, rē-äl'tō, (1) the principal bridge of Venice (q.v.), the only one spanning the Grand Canal. It consists of a single arch 90 feet in span and 24 feet high, and was built of marble at a cost of over $500,000, in 1590. Two ranges of shops divide the bridge road into three narrow parallel streets. Shakespeare mentions the bridge and contiguous promenades as a rendezvous in 'The Merchant of Venice,' and the term has become synonymous with the meeting places of the theatrical profession in most populous centres. (2) The Rialto in New York was first applied to the section on 14th Street, between Broadway and Fourth Avenue; but has now extended to the west portion of Broadway, between 23d and 32d Streets.

Riazan, or **Ryazan,** Russia, (1) city, capital of the government of Riazan; on the Trubesh, a branch of the Oka. It is in an agricultural region; in which the chief product exported is rye. The chief manufactures of the city are woolen and linen goods, leather and needles. Nearby is the village of Grishina, in which are large cutlery works. Pop. about 48,000. (2) The government of Riazan has an area of 16,254 square miles. It is drained by the Oka and its tributaries. The chief manufactures are cotton, linen, and woolen goods, and leather. Rye is the principal grain exported. Pop. about 1,900,000.

Rib. The ribs are a series of flattened, narrow bones which together with the sternum in front and the vertebral column behind form the bony cage which encloses the thoracic organs and supports the muscular structures surrounding the chest cavity. In man there are 12 pairs of ribs, of which the first seven articulate directly with the sternum by means of their costal cartilages and are called the *true* ribs. The cartilages of the eighth, ninth, and tenth ribs join the cartilage of the seventh rib and are, therefore, termed *false* ribs, while the eleventh and twelfth ribs are free at their anterior extremities and are spoken of as the *floating* ribs. The seventh rib is the longest of the series, the others decreasing progressively in size to the first and to the twelfth. The seventh is considered the most representative rib, and is described as having an anterior or sternal extremity, a shaft, and a posterior or vertebral extremity. The sternal end is hollowed slightly to receive the cartilaginous prolongation by which it is connected with the sternum. The shaft is flattened and has an external and an internal surface. Its lower edge is slightly grooved to shelter the intercostal vessels and nerve which run parallel and close to it. The head presents two facets which articulate with the bodies of two adjoining dorsal vertebræ, and the neck is the short portion between the head and the beginning of the shaft. At the junction of the neck with the shaft there is a small swelling called the tubercle which has an articular facet for contact with the transverse process of the lower of the two vertebræ with which the head articulates, and a roughened area for the attachment of a ligament. The rib presents two curvatures, one around a vertical axis, and the other about a horizontal axis, the effect of which is that the bone cannot be laid on a plane surface in such a way that both ends and the shaft between shall be in contact with it. The point at which the curvature is most acute is called the angle of the rib. Most of the ribs are so placed in the body that their sternal extremities are much lower than their points of attachment to the vertebral column, and through this arrangement as well as their peculiar curvature, when they are raised in inspiration the capacity of the thorax is increased both in its anteroposterior and lateral diameters. In some diseases, notably rickets (q.v.) and emphysema (q.v.) which are characterized by changes in the shape of the chest, the ribs undergo alteration in curvature. In children having rickets the anterior portion of the ribs sinks in so that the sternum becomes more prominent and the ends of the ribs may be enlarged and beaded, forming what is called the «rachitic rosary.» If, in addition to rachitis there is present some respiratory obstruction from such causes as adenoids, nasal catarrh, etc., the «pigeon» or «keel» breast may result. In this the lateral compression is carried to a more extreme degree and the cross-section of the chest approaches the triangular shape with the apex forward. A funnel-shaped depression over the lower point of the sternum is sometimes caused by rickets, but may be congenital or due to the habitual pressure of a work bench or tools, as in cobblers, for example. In the emphysematous chest the ribs are thick and run more nearly horizontal so that an increase in the anteroposterior direction and outward bulging of the middle portion are caused, giving rise to the so-called barrel-shaped chest. The flat chest is the opposite of this, as its name implies, and has a short anteroposterior diameter. It is often associated with a tendency to pulmonary tuberculosis. Very rarely the ribs are more or less numerous than normal, but a not unusual deformity is the nonattachment of the anterior end of the tenth rib, so that it, too, is a floating rib. This abnormality is by some authorities considered as an indication of a tendency to neurasthenia. Fractures of the ribs are not infrequent injuries. Owing to the more sheltered position of the upper and the greater mobility of the lower members of the series it is most often the fourth to the eighth ribs that are fractured. Unless there is some complication, such as internal injury, the outlook is usually good. The treatment consists chiefly in immobilizing the side of the chest affected by adhesive plaster strapping. In treating collections of purulent fluid in the pleural cavity, it is often necessary for the surgeon to resect portions of one or more ribs in order to secure free drainage. See ANATOMY, OSTEOLOGY, THORAX.

Ribalta, (1) Francisco de, Spanish painter: b. in Castellon de la Plana, Valencia, about 1550; d. Madrid 12 Jan. 1628. Of the Spanish school of painting, he studied first in Valencia, and afterward in Italy, where he came under the influence of Raphael, Piombo, and the Carracci. Returning to Spain he was received with honor, and engaged to paint pictures for many churches and convents in Valencia. His work is remarkable for grandeur of conception, good taste in composition, freedom of drawing, and correct anatomical design, but like other Spanish painters he was an extremist, depicting alternately agony and ecstacy. Among his best pupils were his son Juan (q.v.), Ribera (q.v.), known as Lo Spagnoletto, and Gregorio Castenada. Of his paintings perhaps the best are: 'Dead Christ and Angels,' 'Saint Francis,' 'Blessed Soul,' and 'Lost Soul,' in the Madrid Museum; 'Saint Francis Embracing Christ,' 'Saint Peter,' 'Conception,' and 'Saint John Baptist,' in the Valencia Museum; 'Virgin and Saint John Returning from the Sepulchre,' at Munich; and 'Saint Joachim and Saint Anne,' 'Christ on the Cross,' and 'Magdalen at Sepulchre,' at Saint Petersburg. He also painted portraits of many prominent Valencians. (2) JUAN DE, his son, flourished about 1597–1628. He painted so nearly in his father's style that their works are often confounded. When 18 he painted the admirable 'Crucifixion' in the Valencia Museum. Among his works are: 'Saints John and Matthew,' 'Saints Mark and Luke,' and 'A Singer,' in the Madrid Museum; 'Pope Gregory the Great Celebrating Mass,' in the Dresden Museum; 'Jephtha's Sacrifice,' and the 'Martyrdom of Saint Catherine.'

Ribault, rē-bō, or **Ribaut, Jean,** French soldier and colonist in the New World: b. Dieppe about 1520; d. Florida 1565. A Huguenot, he was sent by Admiral Coligny to establish a colony of French Protestants in North America. He went out in 1562 with an advance party, with which he built a fortress at Port Royal in the present South Carolina. A garrison of 30, left by him in charge, finally mutinied, and, having slain their leader, set out in a crazy vessel for France. Half-famished, they were carried by an English cruiser to London. Ribault was made governor of a proposed colony in Florida in 1564, and sent out René de Laudonnière, who built Fort Caroline near the mouth of the St. John's. In May 1565 Ribault himself with seven vessels and a force of 300 set sail for the colony, where he arrived 28 August. A Spanish expedition under Pedro Menendez de Avilès, had, shortly after Ribault's arrival, begun work on intrenchments on the site of St. Augustine, and Ribault determined on an attack before the fortifications had been completed. His ships, however, were wrecked in a hurricane, and Menendez, marching overland, captured Fort Caroline and butchered almost all whom he found there. Ribault, with most of his force, was saved, endeavored to return, but was intercepted by Menendez, and with a portion of his followers were murdered. This ended the Huguenot colony in Florida. Consult: Gaffard, 'La Floride française' (1875); Parkman, 'Pioneers of France in the New World' (1885).

Ribbeck, Johann Karl Otto, German philologist: b. at Erfurt, 23 July 1827; d. 1898. In early life he went to Berlin, where he studied under Lachmann, Bopp, and Böckh, and from there to Bonn where he was a close student of the methods of Welcker and Ritschl. Having received his degree in Berlin and traveled for a year through Italy, in 1853, he returned to Berlin, where he entered Böckh's school. He then became a teacher, being called successively to Elberfeld, Bern, Kiel, Heidelberg, and finally, in 1877, to Leipzig, there becoming the successor of his former master, Ritschl. Ribbeck's works are mostly confined to criticisms of Latin poetry and to classical character sketches and display a profound knowledge of the classics combined with a brilliant style of essay. Among them are: 'Vergelii Opera,' with prolegomena and critical notes (5 vols., 1859–69); 'Tragicorum Latinorum reliquiæ' (1862); 'Cornicorum Latinorum reliquiæ' (1855); 'Der echte und unechte Juvenal' (1865); 'Horace's Epistles' (1869); 'Zur Lehre von den Latein Partiketn' (1860); 'Die römische Tragodie im Zeitalter der Republick' (1875); Plautus's 'Miles Gloriosus' (1881); the biography of Friedrich Ritschl (2 vols., 1879–81); 'Geschichte der römischen Dichtung' (3 vols., 1889–92; 2d ed., 1897–1900); and the classical character sketches (which appeared in the *Rheinische Museum,* of which he became editor in 1876) 'Alazon' (1882), 'Kolax' (1885), and 'Agrockos' (1885).

Ribbed Vaulting. See GOTHIC ARCHITECTURE; VAULT.

Ribbon, a narrow web, generally of silk, used for tying and ornamental purposes. Ribbon-weaving is a special branch of the textile industries. In modern looms as many as 40 ribbons are simultaneously woven in one machine. Mixed fabrics of silk and cotton are now largely employed. See SILK AND SILK INDUSTRY.

Ribbon-fish. See DEEP-SEA LIFE.

Ribbon-snake, a garter snake (q.v.) of slender form and conspicuous stripes.

Rib'bonism, in Irish history, the name given a group of secret associations among the lower classes in Ireland throughout the half century extending from 1820–70, at its greatest height from about 1835 to 1855. Its origin and organization are alike wrapped in obscurity, but it appears in the beginning at least to have been political in its aims, and it seems probable that it grew out of the northern Defenders who banded themselves to oppose the Orange organization. Earlier associations with somewhat similar aims were the Whiteboys and the Threshers, and in particular corners of the island, the Carders, Shanavests, and Caravats. Though everywhere condemned by the Roman Catholic clergy, Ribbonism included none but Roman Catholics within its numbers, and it maintained its influence by a system of oaths and secret signs and passwords. One striking feature of Ribbonism, as distinguished from most Irish patriotic associations, was the fact that its adherents belonged exclusively to the very lowest and most ignorant classes, the humbler peasantry, farm servants, laborers, and petty shopkeepers, hardly even the smallest farmers or their sons apparently belonging to it in any part of Ireland. So far as there was any unity in its aims, it aimed at making itself a public conscience on all agrarian questions; but, the Ribbonism of one period and of one district was not the Ribbonism of another. In Ulster it professed to be a defensive or retaliatory league against Orangeism. In Munster it was at first a combination against tithe-proctors. In Connaught it was an organization against rack-renting and evictions. In Leinster it often was mere trade unionism. The name originated in a badge worn by the members.

Ribeiro, rē-bā'roo, **Bernardim,** Portuguese poet: b. Torrão, Alemtejo, about 1486; d. about

1550. He appears to have been a gentleman of the chamber at the Portuguese court and to have been involved in an unhappy love affair with Donna Joana de Vilhena, a relative of the king. He was one of the first to introduce in Portuguese literature the Italian pastoral style which has since prevailed in Portugal. Of his writings there are still extant five idylls and several lyrics beside his best known work, the pastoral romance ‘Menina e Moça’ (1554). Editions of the ‘Obras de Bernardim Ribeiro’ were published in 1645, 1785, and 1852, and in 1891 an excellent edition of ‘Menina e Moça’ with a ‘Prefacio’ was edited by Dom Jose Pessanha.

Ribeiro-Ferreira, fār-rā'ē-rä, **Thomaz Antonio,** Portuguese poet: b. Parada de Gonta, Portugal, 1 July 1831; d. 1901. He was educated for the bar at Coimbra and in 1870 was appointed secretary-general of the Portuguese colonies. In 1878 was appointed colonial secretary, minister of the interior in 1881, and in 1885 and in 1890 was minister of public works. He was minister to Brazil in 1895–6. As a poet he attained high rank, his work exhibiting much grace and a fervid patriotism. His works include: ‘Sons que passam’ (1854); ‘Vesperas’ (1858); ‘Don Jaime’ (1861); ‘Delfino do Mal’ (1868); ‘Dissonancias’ (1890); etc.

Ribera, rē-bā'rä, **José** or **Jusepe de** (known as «Lo Spagnoletto»), Spanish painter: b. Jativa, kingdom of Valencia, 12 Jan. 1588; d. Naples 1656. Although early entered at the University of Valencia, he preferred the studio of Francisco de Ribalta (q.v.) to the schools of book-learning. He eventually left Valencia for Naples, and thence took up his residence at Rome, where he was given the name of Lo Spagnoletto, «the Little Spaniard.» Here he studied the works of Raphael and the Caracci. He also visited Parma and Modena and copied the paintings of Correggio. It is, however, very evident that while he was at Naples Cavaraggio exercised a preponderating influence over his style, and, though a Spaniard, he must be ranked as one of the most pronounced representatives of the Naturalistic School of Naples. Pedro de Madrazo calls him «a most excellent painter, who finds his place among the greatest Italian masters.» Both in coloring, chiaroscuro and anatomical knowledge he excels many of the Neapolitan school; but he generally chose gloomy, austere or revolting subjects for his powerful brush, and these he treated with a wild and extravagant fancy which deepened the horror each incident inspired, such are his ‘Prometheus Chained to the Rock’; ‘The Torment of Sisyphus’; ‘The Flaying of Saint Bartholomew’; ‘Saint Sebastian Transfixed with Arrows’ (all in the Prado Museum, Madrid); ‘The Martyrdom of Saint Lawrence’ (Dresden Gallery). His etchings, of which he has left 26, are mostly figure pictures of great spirit and power. He had a great number of pupils and imitators, among whom were Salvator Rosa and Lucio Giordano. Consult: ‘Diccionario historico de las bellas artes’ (1800); and ‘Diccionario Enciclopedico Hispano-Americano’ (1895).

Ribot, rē-bō, **Alexandre Felix Joseph,** French statesman: b. Saint Omer 7 Feb. 1842. He was educated at the Lycée of St. Omer and studied law in Paris where he was admitted to the bar in 1863. He entered public official life in 1870 and in 1878 entered the Chamber of Deputies for Boulogne-sur-Mer. He was minister of foreign affairs in the cabinet of de Freycinet, 1890–3, assisting in forming the alliance between France and Russia, concluded during that period. In January 1893 he was made president of the cabinet and held this office during the investigations of the Panama scandals; also again in 1895 after the election of Faure as president. He was superseded by Bourgeois in October of that year. His most important speeches have been on finance, foreign affairs, and freedom of education. In the latter cause he took a position opposing the recent persecution of the religious orders and published in 1900 a work entitled ‘Reforme de l'Enseignement secondaire’ embodying his observations as chairman of the committee appointed to make inquiry into the state of secondary education. He has also published ‘Biographie de Lord Erskine’ (1866); and ‘Acte du 5 Août 1873 pour l'Establissement d'une Cour suprême de Justice en Angleterre’ (1874).

Ribot, Augustin Théodule, French painter: b. Breteuil (Eure) 8 Aug. 1823; d. Colombes 11 Sept. 1891. His only schooling in art was obtained by copying pictures in the Louvre. His early works were household and kitchen scenes; ‘Cooks’; ‘The Dinner Hour’; ‘Interior of the Kitchen’; ‘The Merry Cook,’ and ‘Poultry.’ After 1865 he painted religious subjects; but chose to interpret them by selecting scenes of modern life which he gave with a startling realism, ‘Jesus in the Temple’; ‘Saint Sebastian’ and ‘The Good Samaritan,’ now in the Luxembourg gallery are examples in this vein. In his early days he was forced to practise his art during the night hours, and this no doubt confirmed his predilection for concentrated light and strong shadows. In this he is allied to masters of the Dutch school, while in the frank realism of his methods he is classed with Velasquez and Ribera. In later life he painted historical and genre subjects in addition to his earlier field of subjects.

Ribot, Théodule Armand, French psychologist: b. Guingamp 18 Dec. 1839. He was educated at the Lycée de St. Brieure and the Ecole Normal Supérieure, where he was graduated in 1866. He held the chair of philosophy at the lycée of Vesoul and at Laval, 1866–71, when he went to Paris and devoted himself exclusively to researches in experimental psychology in histological and physiological laboratories and in the insane hospitals. In 1876 he founded the ‘Revue Philosophique,’ and in 1885 began his courses at the Sorbonne. Since 1888 he has been professor of experimental and comparative psychology in the College of France. In his first work, ‘La Psychologie anglaise contemporaine’ (1870), he initiated a new school of psychological research in France. The method employed in this work he has consistently followed in succeeding ones. Ignoring all nonmaterial elements in mental life, he seeks his results in the observation and measurement of nervous phenomena in the individual; and the comparison of observed psychological phenomena in races, in infants and in animals. His other works are ‘Psychologie allemande contemporaine’ (1879); ‘Les Maladies de la Mémoire’ (1881); ‘Les Maladies de la Volonté’ (1883);

'Les Maladies de la Personnalité' (1885); 'La Psychologie de l'Attention' (1889); 'L'Hérédité psychologique' (1893); 'Psychologie des Sentiments' (1896); 'L'Evolution des Idées générales' (1897).

Ribs. See ANATOMY; OSTEOLOGY; THORAX.

Ricardo, rĭ-kär'dō, **David,** English political economist: b. London 19 April 1772; d. Gatcombe Park, Gloucestershire 11 Sept. 1823. His father was a prosperous Jew, born in Holland, but settled in England since his youth, and a member of the stock exchange. The son was educated in England and later in Holland, but had no university training and entered his father's business at 14. He married early and conformed to the Christian religion, whereupon an alienation with his father necessitated his taking up business on his own account. In this he was immediately successful and made a fortune on the stock exchange, at the same time preserving an honorable reputation. In 1799 he became interested in Adam Smith's 'Wealth of Nations' and turned his attention to the scientific treatment of questions connected with banking and finance. His first contributions to the subject appeared as letters in the *Morning Chronicle* in 1809 and later appeared in a pamphlet entitled 'The High Price of Bullion a Proof of the Depreciation of Bank-notes.' The report of the bullion committee in 1810 coincided with the principles of Ricardo in its attributing the depreciation of the currency to excessive issues of the Bank of England and in recommending a resumption of cash payments. In 1816 Ricardo proposed a scheme for making bank-notes exchangeable for standard bars of gold bullion instead of coined gold. The scheme was adopted in 1819, but had to be abandoned on account of the temptation to forgery. In 1817 appeared his principal work, 'On the Principles of Political Economy and Taxation.' This work instead of being a historical or philosophical treatment of the general theme is rather a specialized examination of such factors as value, rent, wages, etc., and his contributions to these subjects, while not absolutely original, yet were for the first time stated with fulness and authority. His writings have had a profound influence upon modern doctrines, though his views are not now fully accepted. James Mill and J. R. McCullock were his disciples. He retired from business in 1814, and in 1819 entered Parliament for the Irish borough of Portarlington. He held the seat until his death and contributed to important discussions of financial questions. Consult 'Life' by McCullock (1846).

Ricasoli, rē-kä'sō-lē, BARON **Bettino,** Italian statesman: b. Florence 9 March 1809; d. near Siena 23 Oct. 1880. He first entered public life in 1847 when he submitted to the Grand Duke Leopold of Tuscany, plans of governmental reform which the latter saw himself forced to adopt. Ricasoli became mayor of Florence in 1847 and in the following year was elected to the Tuscan parliament, and helped to bring about the recall of the grand duke. After the battle of Novara (1849) and the restoration of Austrian influence he retired to private life and devoted himself mainly to the scientific study and practice of agriculture. When the revolutionary movement of 1859 compelled the grand duke to flee, Ricasoli became minister of the interior and in August of the same year, dictator. He resolutely opposed all attempts at a restoration of the grand-ducal government and labored for the annexation of Tuscany to Sardinia, which was accomplished in March 1860. He was made, thereupon, governor of Tuscany and was a member of the first Italian parliament which assembled in 1861. In June he succeeded Cavour as head of the ministry and sought to carry out his predecessor's policy, but he could make no head against the opposition and in March 1862, made way for the ministry of Rattazzi (q.v.). He assumed office once more in the early part of 1866, conducted public affairs with ability during the war against Austria, but met with no success in his internal policy of decentralization and financial reform because of his inability to rally a parliamentary majority to his support. He resigned in April 1867, to be followed by Rattazzi, but remained a member of the chamber of deputies till his death, though taking no very active part in affairs. His 'Letters and Papers' were published by Tabarrini and Gotti at Florence in 10 volumes (1886–1894).

Ricciardelli, rēt-chär-dĕl'lē, **Daniele.** See VOLTERRA, DANIELE DA.

Riccio, rēt'chō, or **Rizzio,** rēt'sē-ō, **David,** Italian secretary to Mary Queen of Scots: b. Pancalieri about 1533; d. Edinburgh, Scotland, 9 March 1566. He was educated as a musician, and in 1561 went to Scotland in the train of the Marquis of Moretto, ambassador of the duke of Savoy. At first a singer in Queen Mary's private chapel, in 1564 succeeded Raulet as the queen's secretary. The causes of his elevation have been variously explained. Coincident with the event was Mary's determination to act in matters of state independently of the Scottish nobles or even of her uncle of Lorraine, and the supposition is natural that in Riccio Mary found a safer confidant than in her former French secretary. After the queen's marriage to Darnley in July 1565, Riccio rose even higher in the favor of Mary, and it was Mary's avowed intention to make him her prime minister. His intimacy with the queen aroused the jealousy of Darnley and his haughty behavior made enemies of the nobles. The conspiracy formed to remove the objectionable secretary was precipitated into action by Mary's refusal to pardon Moray and other exiles in England. Its leaders were the relatives of Darnley, Lord Maitland who had fallen from power, and leading Protestants including probably John Knox; with the English government standing as a neutral abettor. Riccio was dragged from the queen's supper-chamber in Holyrood palace and despatched with at least 56 wounds.

Rice, Alice Hegan, American humorous writer: b. Shelbyville, Ky., 11 Jan. 1870. She was educated at Hampton College, Louisville, Ky., and was married to C. Y. Rice, of Louisville, in 1902. Her first book, 'Mrs. Wiggs of the Cabbage Patch' (1901), attained extraordinary popularity, and was followed by 'Lovey Mary' (1903); 'Sandy' (1904).

Rice, Allen Thorndike, American editor: b. Boston, Mass., 18 June 1853; d. New York 16 May 1889. He was graduated from Oxford in 1875 and in 1876 purchased the 'North American Review' of which he became editor. He was one of the promoters of the Charnay expedition which in 1879 investigated the ruins of primitive civilization in Central America and Mexico. He was actively interested in politics, an earnest advocate of a more efficient copyright law, and was chiefly instrumental in securing the introduction of the Australian ballot system into the United States. In 1889 he was appointed minister to Russia, but died befor the date set for sailing. He edited 'Reminiscences of Abraham Lincoln' (1886) and contributed to 'Ancient Cities of the New World' (1887).

Rice, Edmund, American military officer: b. Cambridge, Mass., 1842; d. Wakefield, Mass., 20 July 1906. He entered the Union army in 1861, received rank as captain, was voted a medal of honor by Congress for bravery at Gettysburg, and was mustered out with rank as colonel in 1865. He entered the regular army in 1866, was promoted colonel and in 1877 served for a time on the staff of General Skobeleff in the Turko-Russian war. He was appointed inspector-general in 1898, and in 1902-3 was colonel of the 19th Infantry. He was retired in 1903. The trowel bayonet, stacking swivel, and knife-intrenching bayonet now in use in the United States army were his inventions.

Rice, Isaac Leopold, American lawyer: b. Wachenheim, Bavaria, 22 Feb. 1850. Coming to Philadelphia with his parents in 1856, he was educated at the Boys' Central High School of that city, and showing a genius for music was sent to Paris to complete his musical training. In 1868 he visited England and taught there music and the languages for a year when he settled in New York, teaching music for a time and then entering Columbia Law School, from which he graduated in 1880, taking prizes in constitutional and international law. He founded the School of Political Science and was lecturer (1882-3), and subsequently instructor in the Columbia Law School (1884-6). He is a specialist in railroad law and was counsel and director in the lines now constituting the Southern Railroad, and for a time foreign representative of the Philadelphia & Reading Railway. He has taken an active part in the application of electricity to transportation and is prominently identified with many financial interests. He founded 'The Forum' in 1885 and is a leader in international chess. He has published 'What is Music?' (1875), and has written many articles in leading reviews.

Rice, James, English novelist: b. Northampton 26 Sept. 1843; d. Redhill, Surrey, 26 April 1882. He studied at Queen's College, Cambridge, without taking a degree, and in 1868 became editor and proprietor of 'Once a Week.' He was called to the bar in 1871 and while waiting for clients he became London correspondent for the *Toronto Globe*. His first literary success was with the novel, 'Ready Money Mortiboy' (1872), written conjointly with Walter Besant. The novel was dramatized and produced at the Court Theatre in March 1874. Other novels written in partnership with Besant were 'With Harp and Crown' (1874); 'The Son of Vulcan' (1875); 'The Golden Butterfly' (1876); 'The Monks of Thelema' (1877); 'By Celia's Arbour' (1878); 'The Chaplain of the Fleet' (1879); 'The Seamy Side' (1881). Rice wrote also a 'History of the British Turf' (1879).

Rice, Wallace (de Groot Cecil), American literary critic: b. Hamilton, Ontario, 10 Nov. 1859. He was graduated from Harvard in 1883 and admitted to the Chicago bar in 1884. He has served as reporter and critic on various Chicago papers, and has published 'Under the Stars and Other Songs of the Sea' with B. Eastman (1898); 'Heroic Deeds' (1898); 'Flying Sands' (1898); 'Wild Animals' (1901); etc.

Rice, William Morton Jackson, American painter: b. Brooklyn 18 Feb. 1854. He graduated at Cornell University in 1874 and studied art under Carroll Beckwith in New York, afterward at Paris under Carolus-Duran. In 1886 he became a member of the Society of American Artists and in 1900 an associate of the National Academy of Design. He was awarded a bronze medal at the Pan-American Exposition, 1901.

Rice, William North, American educator: b. Marblehead, Mass., 21 Nov. 1845. He was graduated from Wesleyan University in 1865, and was professor of geology and natural history there 1867-84; and of geology after 1884. He was assistant geologist of the United States Geological Survey 1891-2, and president of the American Society of Naturalists in 1891. He has published 'Geology of Bermuda' (1884); 'Science Teaching in the Schools' (1889); 'Twenty-five Years of Scientific Progress and Other Essays' (1894); and an edition of Dana's 'Text-book of Geology' (1897).

Rice, Wild or **Indian.** See GRASSES IN THE UNITED STATES.

Rice-bird, in the United States the bobolink (q.v.), so called in the South Atlantic, where it is a serious pest in the late autumn to the rice crop; in the East Indies, a familiar and handsome finch-like weaver-bird (*Munia oryzivora*), also known as the Java sparrow and paddy bird. It possesses a large pinkish bill; the head and tail are black, the belly rosy, the cheeks of the male white, and the legs flesh-colored. It is dreaded in southern Asia on account of the ravages it commits in the rice fields, but is frequently brought to Europe and America as a cage-bird.

Rice Industry, American, The. The rice industry had its inception in America about the middle of the 17th century, when Sir William Berkeley made an attempt to raise rice in Virginia in 1647. As this experiment, which was continued for several years, was an utter failure, owing probably to the high latitude in which the seed was planted, it was generally believed that such a crop could not be grown in this country. The fact that this was an error was discovered accidentally, in 1694, when a vessel bound for Liverpool from Madagascar, was blown so far out of her course that, having been somewhat injured by the storm, it was decided to put into Charleston for repairs. Among those who boarded the vessel was Landgrave Thomas Smith, and, at his request, the captain gave him a small package of rough rice to be used as seed. Although little faith was expressed in the success of the experiment

Smith planted it in proper soil in lower Carolina, and his enterprise was rewarded by the growth of a crop that was almost sufficient to meet the needs of the entire colony.

From that day the success of the rice industry was assured. By 1707, the cultivation of rice had extended so widely that no less than 17 ships sailed from Carolina with cargoes of this grain, and, during the 10 years between 1730 and 1739, inclusive, the shipments to Great Britain and other ports amounted to more than 223,787,000 pounds. In 1754, the exports to England alone aggregated over 100,000 barrels of unhusked rice, which was equivalent to 30,000,000 pounds of the cleaned product, and yet the supply that was left was ample for home consumption. From that time until 1784, the yield remained practically the same, but, in that year, the system of water culture was introduced, an innovation which has since resulted in constantly increasing crops.

The following statistical table gives a clear idea of the condition of the industry from the beginning of the 19th century up to 1900, together with necessary information regarding the prevailing tariffs. For the sake of brevity these figures have been grouped in periods of five years, with annual averages. The table is as follows:

PRODUCTION OF RICE IN THE UNITED STATES FOR 105 YEARS, 1795 TO 1900, WITH TARIFF RATES PREVAILING FROM 1789 TO 1857.

Five years ending June 30	Production for five years (Pounds)	Average per year	Tariff on Rice	
			Year enacted	Rate ad valorem
1800....	320,631,803	64,124,361	1789	5 per cent
1805....	240,044,600	48,008,920	1702	7½ "
1810....	274,477,000	54,895,400	1794	10 "
1815....	274,867,800	54,973,560	1800	12½ "
1820....	282,397,800	56,479,560	1804	15 "
1825....	333,447,000	66,689,400	1812	30 "
1830....	417,333,600	83,460,720	1818	15 "
1835....	457,282,200	91,456,440	1832	Free
1840....	429,585,600	85,917,120	1836	15 per cent
1845....	481,669,200	96,333,840	1841	20 "
1850....	543,494,400	108,698,880	1857	15 "
1855....	483,279,600	96,655,920		
1860....	545,592,600	109,118,520		
1865....	115,738,680	23,147,736		
1870....	160,837,790	32,167,558		
1875....	276,704,430	55,340,886		
1880....	415,332,000	83,066,400		
1885....	534,720,400	106,944,080		
1890....	675,950,400	135,190,080		
1895....	762,698,460	152,539,692		
1900....	822,596,280	164,519,256		
1905....	2,232,051,133	446,410,226		
1910....	2,982,233,223	596,446,645		

DUTY FROM 1861 TO 1897.

Specific duty	Cleaned per pound	Uncleaned per pound	Paddy per pound	Flour granulated	Ad valorem equivalent
	Cts.	Cts.	Cts.	Cts.	Cleaned Rice
1861......	1	½	....	....	41 per cent
1862......	1½	1	¾	....	48 "
1864......	2½	2	1½	....	94 "
1876......	Hawaii	an Rice	....	....	Free
1883......	2¼	1½	1¼	ad val. 20% specific	110 per cent
1890......	2	1¼	¾	¼	99 "
1894......	1½	8-10	¾	¼	88 "
1897......	2	1¼	¾	¼	80 "

Although the superiority of American rice was a well-established fact long before the Civil War the success that planters have attained since 1865 has been indicated in a better quality of rice. In the old days, before the war, when Ward's famous "long grain Carolina" rice was the standard of perfection, Georgia and the Carolinas were the only States in which rice was grown to any great extent. In nearly all the other southern States its cultivation was merely for home consumption. Since the war, however, there has been a change in these conditions: Georgia and the Carolinas have retained their rice fields, but other southern States have evinced an increased interest in the cultivation of this product, Louisiana and Texas being particularly notable examples of the gigantic strides which this industry has taken.

The southern rice fields upon which the best commercial crops are grown are the reclaimed cypress swamps and the tide-water lands along the coast. Of course, many of the finest plantations are among the marshes higher up the rivers, or even in the interior upon level tracts that are so situated that they may be irrigated with ease. In nearly all of these plantations the system of water cultivation is followed. In the case of the tide-water lands, they lie along the rivers, above the meeting of fresh and salt water, in such a position that they may be flooded with water when the tide is high and drained at low tide. Thoroughly protected by dikes, the salt water, which is so fatal to the rice, cannot reach them from below, nor can freshets sweep them from above.

The serious check which this industry had received during the war was not forgotten immediately upon the declaration of peace. Lands there were in plenty, but there was no money to operate them, and it was not until incidental protection was derived from the tariff that any vigorous attempt was made to rehabilitate the old plantations. Since that time the greatest advancement has been made in Louisiana, and, during more recent years, in Texas.

The history of rice culture in Louisiana dates back to 1718, but, during all the years prior to the war, this industry was confined chiefly to the parish of Plaquemine. Experience had shown, however, that, in Louisiana, rice was a sure crop, upon which a fair price could be realized quickly without the outlay of a great amount of money, and so, in the uncertain days that followed 1864, it was to rice that the planters turned, with the result that a crop which had never been able to do more than supply a local demand, suddenly sprang into a position of national importance. So great and lasting was this impetus that, by 1875, the State of Louisiana was furnishing fully 30 per cent. of the total yield of the United States, while in each of the five years following 1880, it averaged 40 per cent.; 1885, 60 per cent.; 1890, 65 per cent.; 1895, 75 per cent., and in 1900, no less than 80 per cent. of the aggregate production of the country. In fact, the rice industry in Louisiana has developed to such a marvelous extent during the past 30 years that a statistical illustration of its progress is as important as it is interesting. Given in five-year periods, this is shown on the following page.

The stride that is shown in 1885 is largely due to the opening of an entirely new area to

PRODUCTION OF RICE IN LOUISIANA.

Five years ending June 30	Pounds	Average per year
1865	9,667,080	1,933,416
1870	35,268.590	7,053,718
1875	81,756,030	16,351,206
1880	176,694,000	35,338,800
1885	255.516,200	51,103,240
1890	422,775,000	84,555,000
1895	555.595.400	111,119,080
1900	547,104,000	109,420,800

Prior to the war, the annual product was about 1,000,000 pounds.

the cultivation of this product. This portion of the State, which was known as the «Calcasieu Country» section, extended from the Atchafalaya River on the east to the Sabine River on the west.

It was the opening of this southwestern section of Louisiana that tended to call attention to Texas as a possible rice-producing State. There were good lands in plenty. All that was required was the experiment, for when it was made the result was so highly satisfactory that, although there was practically little rice grown in Texas prior to 1900, the report of the next five-year period will show such a complete change in the situation that Louisiana will no longer be able to boast of having raised such an enormous percentage of the aggregate yield, and as both southwest Louisiana and Texas offer a most promising field to investors who are able to develop the lands under the canal system of irrigation there is little reason to believe that either of these sections of the country have commenced to show what marvels they can perform as the great rice-growing centres of the Union.

Rice Lake, Wis., city, in Barro County; on the Red Cedar River, and on the Chicago, Milwaukee & Saint Paul railroad; about 45 miles north by west of Eau Claire. It is in a lumber region and the chief industries are connected with farm and lumber products. It has public and parish schools, a public library and private business schools. Pop. (est.) 3,100.

Rice Paper, also called **Pith Paper**, and more properly, as the substance is not derived from rice. The product of a small tree, 10 to 15 feet high, known botanically as *Aralia* (*Fatsia*) *papyrifera*, which grows in many portions of Formosa. Japanese name, Tsuso; Chinese name, Tung Tsao. The pith is extracted by breaking the bark and outer woody portion, and forcing out the cylindrical core. Consul Jas. W. Davidson states that the paper is produced by skilfully paring these cylinders of pith with a sharp knife as they are rolled upon the surface of a tile or other hard substance that will serve as a bed plate, the thickness of the sheet of pith paper being regulated by the angle at which the knife is held. The sheets are put under heavy pressure for a time, and are finally cut into squares of 3½ inches, and packed 90 in a package. There are three grades of the paper, which is chiefly used for the manufacture of artificial flowers, and also for the painting of small fancy pictures, and to some extent for sun hats. Tamsui is the port of shipment, and as high as 28,000 pounds have been exported in a single year, worth over 15,300 yen. See also PAPER.

CHARLES RICHARDS DODGE.

Rich, Edmund. See EDMUND, SAINT.

Rich Hill, Mo., city in Bates County; on the Osage River; and on the Kansas City, F. S. & M., and the Missouri Pacific R.R.'s; about 83 miles south of Kansas City. It is in an agricultural and coal region; in the vicinity of the largest coal fields in Missouri. Its chief industries are connected with the mining and shipping of coal. It has vitrified brick works, canning factories, a foundry, distillery, machine shops, and zinc smelters. It has an extensive trade in coal, farm products, canned goods, and brick. The principal public buildings are the churches and schools. Pop. (1890) 4,008; (1900) 4,053; (1910) 4,180.

Rich Mountain, Battle of. After the reverse of Col. Porterfield at Philippi (see PHILIPPI, ENGAGEMENT AT) Gen. Lee ordered Gen. H. A. Wise to the Kanawha Valley and Gen. R. S. Garnett to the Cheat Mountain region. Garnett was to relieve Porterfield, recover lost ground, and secure control of the Baltimore and Ohio Railroad. With one regiment he arrived at Huttonsville on 14 June, where he found Porterfield with about 1,400 men. Leaving Porterfield at Huttonsville with three companies to guard his line of communication with Staunton, Garnett marched on the night of the 15th to Beverly, from which point a regiment, a company of cavalry, and two guns were sent by the Parkersburg road to the west foot of Rich Mountain, seven miles west of Beverly. Garnett, with the other regiment, two guns, and a company of cavalry pushing on to Laurel Hill, the northern extension of Rich Mountain, 17 miles northwest of Beverly. These positions were regarded as the gates to northwestern Virginia, and both were strongly fortified. By 1 July Garnett had nearly 4,000 men, including his reserve at Beverly and Huttonsville.

Gen. McClellan arrived at Grafton 23 June, and prepared to expel the Confederates from their positions and to enter the Shenandoah Valley. He had 20,000 men; 5,000 along the line of the Baltimore and Ohio Railroad; a brigade of over 3,000 and a battery, under Gen. T. A. Morris, were stationed at Philippi; and by 2 July the main column, under his own immediate command, was concentrated at Buckhannon, 24 miles west of Beverly. This column of over 10,000 men, with 12 guns, was organized into three brigades, under Gens. W. S. Rosecrans and N. Schleich, and Col. R. L. McCook. On 2 July Gen. J. D. Cox was ordered to cross the Ohio with a brigade, and co-operate with McClellan by moving up the Kanawha Valley against Gen. Wise. On 6 July Morris was ordered to march his brigade from Philippi to within a mile and a half of Garnett's position at Laurel Hill, and on the 9th McClellan had the three brigades of his own column at Roaring Creek, two miles from the west foot of Rich Mountain, where Lieut. Col. John Pegram was intrenched, with 1,300 men and four guns. Preparations were made to assault Pegram in front with Rosecrans' brigade, on the morning of the 11th, but on the evening of the 10th Rosecrans learned that Pegram's rear could be reached by a difficult route around his left, and proposed to do it with his brigade. To this McClellan assented. It was arranged that Rosecrans should march at daybreak of the 11th, with about 1,900 men, gain the road in Pegram's rear, march down it and attack, and that at the sound of the engagement in rear McClellan would attack in front. Rosecrans, after a very hard march, made the turning movement, and coming to the road about 3 P.M., unexpectedly came under fire of musketry and artillery and was checked. Pegram had been warned of danger to his rear, and during the morning had sent two detachments to Hart's farm, at the summit of the mountain, with Maj. J. A. De Lagnel in command, who took with him a gun of his battery, and threw up breastworks for his 310 men. Rosecrans attacked, was at first repulsed, and it was not until after a sharp engagement of nearly two hours that he succeeded in driving the Confederates from position, just as Pegram was approaching with reinforcements and another gun. A part of the reinforcements became involved in the defeat, and Rosecrans captured the two guns. Nothing had been heard from McClellan, and knowing that a considerable body of Confederates was still near him, Rosecrans directed his men to lie on their arms until morning. Rosecrans lost 12 killed and 49 wounded. The Confederates had made a gallant fight, with a loss of 40 to 45 killed and about 25 wounded. The noise of the engagement had been heard in McClellan's ranks, and he prepared for an attack in front, but the long continuance of the artillery-fire on the mountain, and some cheering in Pegram's camp, impressed him that it had gone badly with Rosecrans, and the attack was not made, and near night he withdrew his troops beyond Roaring Creek. At daybreak of the 12th Rosecrans found that the Confederates had disappeared and, marching down the mountain, he entered Pegram's abandoned camp, taking two more guns, with some sick and wounded, and as nothing was seen of McClellan, he sent him word of what he had been doing and where he was.

The forces engaged with Rosecrans on the mountain top succeeded in passing around his right during the night to Beverly, where they were joined by the 44th Virginia, and the retreat was continued through Huttonsville and across Cheat Mountain to Greenbrier River, and then to Monterey. Pegram abandoned his works, intending to follow his detachment to Beverly, but in the darkness his column was broken up, part reaching that place. Pegram led the remainder to join Garnett, marching all day of the 12th, and halting at night in the valley six miles north of Beverly. There, hearing that Garnett had retreated northward, and that McCellan was at Beverly, and seeing no chance of escape, he sent to McClellan an offer of surrender. This was accepted, and next morning Pegram surrendered 30 officers and nearly 500 men. Garnett, at Laurel Hill, informed of the disaster that had befallen Pegram on the 11th, abandoned his works after dark, and retreated toward Beverly. When within five miles of the place, at daybreak of the 12th, he received erroneous information that McClellan had already occupied it, whereupon he retraced his steps and retreated north toward Saint George and West Union, hoping to escape by the Northwestern Turnpike, but was overtaken by Morris at the fords of Cheat River, at noon of the 13th, and killed in a rearguard fight at Corrick's Ford. His army continued the retreat through Red House, Greenland, and Petersburg to Monterey. McClellan occupied Beverly on the 12th and Huttonsville on the 14th, and pushed his advance to the summit of Cheat Mountain. Leaving a force on Cheat Mountain and at Huttonsville he returned to Beverly on the 16th. A few days later McClellan was called to Washington and assigned to the command of the troops for the defense of the city. On 1 November he became commander of the Army of the United States. His short and successful campaign, with that of Gen. Cox up the Kanawha Valley, settled the fate of West Virginia, stimulated the Union men in their effort to form a new government, and finally resulted in the dismemberment of Virginia and the formation of the new State of West Virginia. Consult: 'Official Records,' Vol. II.; The Century Company's 'Battles and Leaders of the Civil War,' Vol. I.

E. A. CARMAN.

Richard I., king of England: b. Oxford 8 Sept. 1157; d. Chaluz, France, 6 April 1199. He was the 3d son of Henry II. of England and Eleanor of Aquitaine and while an infant was betrothed to Alice, a daughter of Louis VII. of France. Made duke of Aquitaine in boyhood, he took part in the rebellion of his brothers against his father, who at different times attempted to deprive Richard of his possessions, and even planned to exclude him from the succession to the crown in favor of the younger son John. In 1189, in conjunction with Philip Augustus of France, he waged war on his father and compelled Henry II. to acknowledge his right to the throne. Two days after the conclusion of peace Henry II. died at Chinon (6 July 1189). In September, he was crowned king at Westminster and immediately began preparations for a crusade to the Holy Land, in fulfilment of a vow made two years before. To raise money for the expedition he sold fiefs and offices, surrendered to William the Lion of Scotland the suzerainty over that country and increased the burden of taxation. Proceeding through France he joined the army of the French king at Messina where he became involved in a conflict with Tancred, king of Sicily, in the course of which the English king made himself master of Messina. The intrigues of Philip Augustus brought on enmity between the two sovereigns and Richard repudiating his betrothed, Alice, sister of the French king, secured the hand of Berengaria of Navarre, who joined him at Cyprus where they were married. After he had conquered the island and seized its treasures he joined the crusading army before Acre (8 June 1190). Between the English and the French bitter feelings now prevailed and at one time hostilities were threatened. Acre, nevertheless, was taken by the crusaders, and in August Philip sailed for Europe. War with Saladin (q.v.) was renewed on account of Richard's atrocious massacre of 2,700 Mohammedan prisoners. At Arsuf, 7 September, Richard won a decisive victory and in spite of prolonged negotiations moved on Jerusalem, arriving in December 1191 within a very short distance of the city. He fell back to Ascalon where the contest between

Guy of Lusignan and Conrad of Monferrat for the kingdom of Jerusalem was productive of dissensions among the crusaders. A second advance on Jerusalem met with ill success and in August 1192, Richard concluded a three years' truce with Saladin and left the Holy Land, having made no conquest beyond that of Acre. Shipwrecked in the Adriatic, he attempted to make his way disguised through Germany, but was taken prisoner near Vienna by his enemy, the Duke of Austria, who handed him over to the Emperor. Brought before the imperial diet, Richard pledged himself to a ransom of 150,000 marks and received his English kingdom as a fief from the Emperor. The influence of the French king and Richard's own brother was effectual in prolonging the English king's imprisonment. Liberated in March 1194 he landed in England in the same month and was crowned a second time. John was forced to submit and Richard, collecting all the money he could for a war with Philip of France, sailed for Normandy in May. The contest which dragged on for five years presents little that is noteworthy, and in January 1199 peace was made. While besieging the castle of Chaluz, held by a vassal with whom Richard disputed the possession of a newly found treasure, the king was wounded by an arrow and died in his tent. Richard I. owes his fame to the glamor with which legend has surrounded his name as the typical warrior of the Middle Ages. As a king he did nothing for England; his great passion was war, and the only redeeming features in a character of violence and ferocity are a certain naive magnanimity and the splendid courage which gained him even in his lifetime the title of Cœur de Lion, «Lion-hearted.» The legend which recounts how Richard immured in an Austrian prison was discovered by his favorite minstrel, Blondel, who had wandered throughout Europe singing his songs outside of castle walls, dates from the second half of the 13th century. Richard figures prominently in Scott's 'Ivanhoe' (1820); and 'The Talisman' (1825), and in Maurice Hewlett's 'Richard Yea and Nay.' Consult Stubbs, 'Early Plantagenets' (5th ed. 1886); Norgate, History of the Angevin Kings' (1887); Archer, 'Crusade of Richard I.' (1889); Round, 'Feudal England' (1895); Stubbs, 'Constitutional History of England,' Vol. I. (6th ed. 1897).

Richard II., king of England: b. Bordeaux 6 Jan. 1367; d. Pontefract, Yorkshire, February 1400. He was a younger son of the Black Prince and a grandson of Edward III. and succeeded to the throne on the death of his grandfather in June 1377, at a time when England was suffering from the effects of the black death, the demoralizing results of the war with France and the misgovernment by faction that marked the latter part of the reign of Edward III. The young king was placed under the control of a council in which his uncle, John of Gaunt, Duke of Lancaster, exercised a predominant and, on the whole, pernicious influence. Popular disaffection, fed by the ill success of the government in repelling attacks on the part of the French and the Scots, was intensified by the increasing burden of taxation. The imposition of a new capital tax in 1380 led to the outbreak of the celebrated Peasants' Revolt in 1381. (See TYLER INSURRECTION.) Richard displayed great presence of mind in dealing with the insurgent forces near London, and to his bearing was largely due the speedy suppression of the revolt, which was directed largely against John of Gaunt. In 1382 he married Anne of Bohemia and about the same time sought to free himself from the control of Parliament by building up a party of his own with Robert de Vere, Earl of Oxford, and Michael de la Pole, Earl of Suffolk, as a nucleus. Richard thereby came into conflict with John of Gaunt who in 1386 departed for France. The leadership of the opposition fell to the unscrupulous Duke of Gloucester, the youngest of the king's uncles. In 1387 Parliament, controlled by Gloucester, demanded the dismissal of the chancellor de la Pole, and of Oxford, who had been made Marquis of Dublin with sovereign rights in Ireland, and though the king refused to yield, he was compelled to accept a committee of 11 appointed by Parliament with extensive power of government for a period of one year. Suffolk was dismissed. When Richard set himself to overthrow the committee, the Duke of Gloucester and the earls of Arundel, Derby, Nottingham and Warwick, took up arms, marched on London, demanded the trial of five of the king's principal advisers on the charge of treason, and brought about their condemnation by Parliament. Forced to submit for a time, Richard succeeded in throwing off his uncle's authority in 1389 and for the ensuing eight years ruled with moderation and in peace. He had not abandoned, however, his views on the absolute authority of kings and had not forgiven the party of Gloucester for their persecution of his former supporters. In 1387 Gloucester, Arundel and Warwick were seized, and a packed and intimidated Parliament condemned the three to death. Arundel was executed, and Warwick imprisoned. Before sentence could be carried out on Gloucester, news of his death came; that death was probably a violent one. The earls of Derby and Nottingham were spared and raised to the dignities of Duke of Hereford and of Norfolk. Extensive powers were surrendered by Parliament to the king and his triumph was complete. A quarrel between Hereford and Norfolk led to their banishment from England in 1388 and on the death of Hereford's father, John of Gaunt, Richard seized the Lancastrian estates. In May he went to Ireland for the settlement of the affairs of that country and Hereford seized the opportunity of invading England, ostensibly for the purpose of recovering his estates. When Richard landed in England in August, he found himself abandoned by his followers and Henry of Lancaster in possession of power. On 19 August he gave himself up to Henry at Flint in Wales. He was brought to London and on 29 September resigned the crown in favor of Henry, who on the following day, took the royal title with the consent of Parliament. Richard was sentenced to strict imprisonment and was removed to Henry's castle of Pontefract. There he died, probably by violence, though his body was publicly exposed to refute the charge. Richard was a patron of Chaucer and Gower and was favorably inclined to the teachings of Wyclif. Consult Wallon, 'Richard II.' (1864); Stubbs, 'Constitutional History of England,' Vol. II. (4th ed. 1896).

Richard II., a historical play by Shakespeare, produced between 1594 and 1596. It is based on Holinshed's 'Chronicle' and narrates the story of the supplanting, on the throne of England, of the weak-willed Richard II., by the politic Bolingbroke (Henry IV.). It is the earliest in point of time of the historical dramas and in 1720 an adaptation of it was made by Theobald. It is now and then seen upon the stage but much less often than 'Richard III.,' 'King John' or 'Henry IV.'

Richard III., king of England: b. Fothering Castle in Northamptonshire, 2 Oct. 1452; d. Bosworth, Leicestershire, 22 Aug. 1485. He was the youngest son of Richard, Duke of York, and upon the accession of his brother to the throne as Edward IV. he was created Duke of Gloucester and received the grant of extensive lands with the office of admiral. With Edward he fled to Holland in 1470, and with him returned in the following year, commanding the Yorkist vanguard against the Lancastrian forces at Barnet and Tewkesbury, where he distinguished himself by his courage and skill. There, too, he gave signs of his innate ferocity, by his execution of the Lancastrian commander Somerset and others. The murders of Edward, Prince of Wales, after Tewkesbury, and that of Henry VI. in the Tower are also ascribed to him. Richard became grand-chamberlain of England, and, marrying Anne, the younger daughter of Warwick, fell into violent disputes with his brother Clarence who was the husband of an elder daughter. The death of Clarence in 1478, for which Gloucester cannot be made directly responsible, greatly enriched the latter. In 1480 he became lieutenant-general of the north and in 1482 carried on a victorious campaign in Scotland. Edward IV. died in April 1483 leaving Richard as guardian of his 13-year-old son Edward and protector of the kingdom. Richard's first move after securing possession of the king was to seize the queen-mother's relatives, who were soon after sent to execution. Lord Hastings, who at first sided with Richard but showed signs of disaffection at his ambitious schemes, was likewise put out of the way. With the aid of the Duke of Buckingham Richard began openly to work for the crown. Doubts were cast on the legitimacy of Edward IV.'s children and in June a subservient Parliament asked Richard to assume the crown. This he did 26 June, though the coronation did not take place till 6 July. Soon after the young sons of Edward IV. were done to death in prison. Buckingham now began to plot against Richard and in October stirred up an insurrection in Wales and the southern counties, but the movement collapsed and Buckingham was sent to the scaffold (2 Nov. 1483). More than a year of peace followed during which Richard acquired much popularity by his wise legislative measures and energetic administration. Early in August 1485, Henry, Earl of Richmond, Lancastrian claimant for the throne, landed in England, and Richard going to meet him was defeated and slain at Bosworth Field, after a display of heroic valor. The popular conception of him as a dwarf and hunchback rests on no good authority. Undeniably he was a man of fine powers and bid fair to become one of England's ablest rulers; undeniable, too, however, are his ruthless ferocity and total lack of moral consciousness. Consult: 'Letters and Papers of the Reigns of Richard III. and Henry VI.,' edited by Gairdner (Rolls Series 1861-3); Fabyan, 'The New Chronicles of England and France' (1811); Walpole, 'Historic Doubts on the Life and Reign of Richard III.' (1768); Legge, 'The Unpopular King: Life of Richard III.' (1835); Jesse, 'Memoirs of Richard III.' (1862); English Historical Review, Vol. V. (1891); Gairdner, 'Life and Reign of Richard III.' (1898).

Richard III., a historical drama by Shakespeare, the last of a closely linked group of historical tragedies. It was printed anonymously in 1599, but in the next year it appeared with Shakespeare's name. For nearly two centuries, or from 1700 to 1876, Cibber's alteration of the text was the only version seen upon the stage, but in the last named year Edwin Booth restored the Shakespearian version. By some authorities the play is supposed to have been a completion and alteration by Shakespeare of an earlier play by Marlowe on the same subject. It is still a popular play on the boards.

Richard Plantagenet, plăn-tăj'ĕ-nĕt, EARL OF CORNWALL, titular emperor of Germany, younger son of King John of England: b. Winchester, Hampshire, 5 Jan. 1209; d. Kirkham, Lancashire, 2 April 1272. He fought against France, in the army of his brother Henry III., went on a crusade to Palestine, and on his return to England in 1242 again assisted his brother in a war against France, but was soon after deprived of his French domain Guienne. In 1256 he was chosen emperor of Germany by a faction while the opposing party declared Alfonso X. emperor. He was crowned king of the Romans in 1257, but was unable to obtain general recognition though he exercised all the rights of a sovereign. In 1264 he returned to England to assist his brother and was taken prisoner at the battle of Lewes, 13 May 1264. He returned to Germany in 1268, held a diet at Worms in 1269, after which he returned to England. He was one of the ablest and wealthiest princes of his day.

Consult: Lorenz, 'Deutsche im 13. und 14. Jahrhundert' (1863-7); Schirrmacher, 'Die letzten Hohenstauffen' (1871); Koch, 'Richard von Cornwall 1209-1257' (1888).

Richard Carvel, a historical novel by Winston Churchill, published in 1900. It is a story of the Revolutionary period and the hero, Richard Carvel, spends his early life in Maryland, where he is brought up by his grandfather, an ardent supporter of King George. The climax of the story is reached in a brilliant description of the victory of the Bon Homme Richard over the Serapis, in which battle Carvel is severely wounded.

Richard of Cirencester, sĭs'ĕ-tėr, English chronicler of the 14th century. All that is known of his life is that he entered the Benedictine monastery of St. Peter's, Westminster, and was there in 1350; that in 1391 he obtained permission from his abbot to make a visit to Jerusalem; and that he died in his monastery in 1400 or 1401. He is the author of 'Speculum Historiale de Gestis Regum Angliæ,' a compilation from other chronicles, giving an account of the kings of England from 447 to 1066. His name is best known, however, in connection with a forgery of the 18th century. In 1747 Charles Bertram, an English teacher in Copenhagen, wrote to the well known English antiquary, Stukeley, that a friend of his had a manuscript work on Roman Britain, by a monk named Richard of Westminster, and a transcript of the MS. was subsequently forwarded, with a few lines in facsimile. The author was soon identified with Richard of Cirencester, who henceforth passed for the writer of a valuable Latin treatise, 'De Situ Britanniæ.' The work was published in Copenhagen in 1757 and passed as authentic until B. B. Woodward, librarian of Windsor Castle, exposed the forgery in 1866.

Richard Roe. See Doe, John.

Richards, rĭch'ardz, **Charles Brinckerhoff,** American engineer: b. Brooklyn, N. Y., 23 Dec. 1833. He was educated privately, and for many years was superintendent of the Colt's Arms Company at Hartford. He occupied a similar post with the Southwark Foundry and Machine Company at Philadelphia in 1880–4, was consulting engineer for numerous public buildings and since 1884 has filled the chair of mechanical engineering at Yale. He invented in 1861 the indicator for steam-engines, which bears his name; was one of the United States expert commissioners at the Paris Exposition in 1889, and prepared a large share of their official report; and is a member of various American and European scientific societies. He was editor of engineering and technical terms in Websters 'International Dictionary.'

Richards, Ellen Henrietta Swallow, American chemist and educator: b. Dunstable, Mass., 3 Dec. 1842. She was graduated from Vassar in 1870, from the Massachusetts Institute of Technology in 1873, and in 1875 was married to Robert Hallowell Richards. She has been an instructor at the Massachusetts Institute of Technology since 1876, is chemist of the Manufacturers' Mutual Fire Insurance Company, and is also a specialist in water analysis. She has published 'Chemistry of Cooking and Cleaning' (1882); 'The Cost of Living' (1899); 'Air, Water, and Food' (1900); etc.

Richards, Henry Brinley, Welsh pianist and composer: b. Carmarthen, Wales, 13 Nov. 1819; d. London 1 May 1885. He was educated at the Royal Academy in London, gained a high position as a pianist and became a director and professor at the Academy. He made a specialty of Welsh music on which he frequently lectured, and won popularity by his compositions which include pianoforte pieces, part songs, songs, orchestral pieces, etc. His works include: 'Overture in F minor, for Orchestra' (1840); 'The Harp of Wales' (1863); 'God Bless the Prince of Wales' (1863); 'Let the Hills Resound' (1873); etc.

Richards, Laura Elizabeth Howe, American writer of juvenile fiction: b. Boston 1850. She is a daughter of Mrs. Julia Ward Howe (q.v.), and was married in 1871 to Henry Richards of Gardiner, Maine, where she has since resided. Among her numerous popular works are: 'The Joyous Story of Toto' (1885); 'Queen Hildegarde' (1889); 'Captain January' (1890); 'Three Margarets' (1897); 'The Green Satin Gown' (1903).

Richards, Thomas Addison, author and artist: b. London 3 Dec. 1820; d. Annapolis 29 June 1900. He came to the United States in 1831 and settled in Georgia. He studied art at the National Academy in New York and with Daniel Huntington, and at an early age began writing and illustrating for publication. He organized the Woman's School of Design at Cooper Union in 1859 and was its first director. In 1868 he became professor of art in the University of the City of New York and after 25 years' service was made professor emeritus. He was a constant exhibitor at the National Academy of Design, became an associate in 1848, an academician in 1851, and was member of the council and corresponding secretary 1852–92. In the early '50s he was a frequent contributor of pictures and text to 'Harper's Magazine,' describing in his articles scenes in the United States and the homes of American authors. His landscape paintings produced in many parts of the United States and Europe are illustrative rather than creative. He was the author and illustrator of 'The American Artist' (1848); 'Georgia Illustrated' (1851); 'Romance of American Landscape'; 'Summer Stories of the South'; 'Pictures and Painters.'

Richards, William Trost, American artist: b. Philadelphia, 14 Nov. 1833; d. Newport, R.I., 8 Nov. 1905. He first studied under Paul Weber and in 1855 went abroad for observation and study in Italy and Paris, establishing a studio in Philadelphia in 1856. In his landscapes he adopted the minute method of drawing characteristic of the English Pre-Raphaelites, though he resembled them in no other respect, his subjects being transcripts rather than composed pieces. His greatest success was in his marines where he carefully studied the motion of waves in storm and calm. He painted numerous subjects along the Atlantic coast, especially near Newport where he later lived. He exhibited at the Royal Academy, London, at the Paris Salon and the various American Expositions. He was a member of the National Academy of Design. A series of his water-color marines hangs in the Metropolitan Museum, New York.

Richardson, rĭch'ard-sŏn, **Abby Sage,** American lecturer and author: b. Massachusetts 14 Oct. 1837; d. Rome, Italy, 5 Dec. 1900. She was married to Daniel MacFarland, and in 1866 made her début as an actress. In 1868 she was divorced from MacFarland and was engaged to marry Albert Deane Richardson (q.v.) when he was shot by her former husband in 1869. She was married to Richardson a few days before his death and then retired from the stage, afterward devoting herself to lecturing and writing. She made several adaptations of plays from the French and her last work was a dramatization of Weyman's 'Sophia.' Her works include: 'Stories from Old English Poetry' (1871); 'Old Love Letters' (1883); 'Abelard and Heloïse' (1884); etc. In collaboration with Grace Furniss she adapted the plays: 'The Pride of Jennico' and 'The Colonial Girl.'

Richardson, Albert Deane, American journalist: b. Franklin, Mass., 6 Oct. 1833; d. New York 2 Dec. 1869. He was a war correspondent for the New York *Tribune* during the Civil War and while trying to run the batteries of

Vicksburg in 1863 was taken prisoner and held for 18 months. He was shot by Daniel MacFarland 26 Nov. 1869 and died a few days later. His miscellaneous writings were published by his widow, Abby Sage Richardson (q.v.), with the title 'Garnered Sheaves' (1871), and his other works include: 'The Field, the Dungeon, and the Escape' (1865); 'Beyond the Mississippi' (1866); 'A Personal History of Ulysses S. Grant' (1868); etc.

Richardson, Sir Benjamin Ward, English physician: b. Somerby, Leicestershire, 31 Oct. 1828; d. London 21 Nov. 1896. He was educated at Anderson College, Glasgow, and St. Andrews University, and in 1855 removed to London and for three years was lecturer on medical jurisprudence at the School of Medicine, in Grosvenor Place, and until 1865 lecturer on physiology. Sanitary reform and methods of producing anæsthesia were the two fields in which he was especially interested. Of the 14 anæsthetics that he brought into use methylene bichloride is most widely known. He introduced the ether spray for local anæsthesia, and the lethal chamber for the humane extinction of the life of animals. He also discovered the properties of amyl nitrite and introduced a number of bromides and other substances into use by the medical profession. He was a strong advocate of total abstinence from the use of alcohol, on the ground that its power as a drug required the greatest caution in its use. Aside from his scientific writing he produced biographies, plays and poems. The «Asclepiad,» a series of original researches in the science, art and literature of medicine, was written entirely by himself and appeared quarterly from 1884 to 1895. Besides works already mentioned he wrote 'Diseases of Modern Life' (1876); 'National Health' (1890); etc.

Richardson, Charles, English philologist: b. London 5 July 1775; d. Feltham, Middlesex, 6 Oct. 1865. He studied law, but early turned his attention to literary pursuits and afterward opened a school at Clapham. He was pensioned in 1852. His works include: 'Illustrations of English Philology' (1815); 'New Dictionary of the English Language' (1837); 'On the Study of Languages' (1854); etc.

Richardson, Charles Francis, American educator: b. Hallowell, Maine, 29 May 1851. He was graduated from Dartmouth in 1871, was editor of the New York 'Independent' in 1872–8, of the Philadelphia 'Sunday School Times' in 1878–80, and of 'Good Literature,' New York, in 1880–2. Since 1882 he has occupied the chair of English at Dartmouth. He has published: 'A Primer of American Literature' (1878); 'The Cross,' poems (1879); 'The Choice of Books' (1881); 'American Literature 1607–1885' (1886–8); 'The End of the Beginning' (1896); etc.

Richardson, Ernest Cushing, American librarian: b. Woburn, Mass., 9 Feb. 1860. He was graduated from Amherst in 1880 and from Hartford Theological Seminary. In 1883–90 he was professor and librarian at the latter institution and since 1890 has been librarian at Princeton. He was American editor of Berner's 'Jahresberichte d. Geschichtswissenschaft'; critical editor of 'Hieronymus w. Gennadius de Viris Inlustribus' (1896); and wrote: 'Biographical Synopsis of the Ante-Nicene Fathers' (1887); 'Classifications, Theoretical and Practical' (1901).

Richardson, Henry Hobson, American architect: b. Parish of St. James, La., 29 Sept. 1838; d. Boston 27 April 1886. He was graduated at Harvard in 1859 and in the following year went to Paris and entered the Ecole des Beaux Arts. Throughout his student life in Paris he worked under the instruction of L. J. André, and when his private fortune was swept away by the Civil War he secured through André's friendship an appointment in a government office in Paris. In 1865 he returned to the United States and located his business in New York. His first commission, received in October 1866, was for building the Church of the Unity in Springfield, Mass. The design of this church is the only instance of his following Gothic models; and this, which may in general terms be typical of the English Rural Gothic, yet presents certain independent features that show the practical bent of his mind. Shortly afterward he built the Boston & Albany railroad office in the same city and Grace Church in West Medford. In October 1867 he formed a partnership with Charles Gambrill which lasted until October 1878. The works of this period, which include several of his more important ones, and especially Trinity Church in Boston, were projected under the firm name, though with few exceptions were the conceptions of Richardson. In 1870 the commission was received to build the Brattle Street Church in Boston and the design he produced, Romanesque in general character, may be regarded, however, as rather transitional to that style that he worked in so consistently in the latter part of his life, and which received its first confirmation in the North Church of Springfield, built by him in 1872. The Brattle Street Church, now known as the First Baptist Church, has a fine tower ornamented below the upper arcade by a bold sculptured frieze. The church itself is ineffective in respect to the relations of its general masses with this superb tower, and, its acoustic properties being imperfect, the work is judged a partial failure.

Trinity Church in Boston was begun in 1872 and finished in 1877. This church shows the perfection of his individual style evolved from his study of the Romanesque churches of southern France. It is cruciform in plan, but its distance from apse-wall to façade is only about 39 feet in excess of the distance between the two walls of the transepts. This innovation in church architecture has had a powerful effect upon subsequent designs. After Trinity he produced only two other, and these comparatively unimportant churches, though he entered the competition for the Cathedral Church at Albany. His subsequent work was in the designing of municipal or commercial structures, and of these the one by which he wished to be judged was the Allegheny County Buildings – Courthouse and Jail, of Pittsburg, Pa. These structures, however, he did not live to see completed. Other buildings designed by him are Sever Hall, and the Law School of Harvard University; the City Hall at Albany; parts of the New York State Capitol at Albany, in which he was associated with Leopold Eidlitz and Frederick Law Olmsted, his individual work being the Senate chamber, the Governor's room, the Court of Appeals chamber and the Western staircase; the Chamber of Commerce at Cincinnati and the Field Building at Chicago. Other buildings such as stores, railway stations, public libraries and private dwellings were designed by him. Consult: Van Rensselaer, ‘Henry Hobson Richardson, and His Works’ (1888).

Richardson, Sir John, Scottish naturalist and Arctic explorer: b. Dumfries, Scotland, 5 Nov. 1787; d. Lancrigg, near Grasmere, Scotland, 5 June 1865. He was educated at the University of Edinburgh and in 1807 entered the navy as assistant surgeon. In 1819 he was appointed surgeon and naturalist to Sir John Franklin's expedition to Hudson Bay and the Coppermine River. He was appointed surgeon of the Royal Marines at Chatham in 1824, but accompanied Franklin on his second Arctic expedition in 1825, resuming his duties at Chatham in 1827. He was knighted in 1846 and in 1848 set out with Rae in search of Franklin. The search was fruitless so far as finding trace of Franklin, but Richardson gained valuable information concerning the physical conditions of North America. In 1855 he resigned his position as surgeon to the Hasler Hospital at Gosport, which he had held since 1838. He was author of the articles “Ichthyology” and “Franklin” for the Encyclopædia Britannica; Vols. I. and III. of ‘Fauna Boreali-Americana; and also published: ‘A Voyage Through Rupert's Land and the Arctic Sea’ (1851); ‘The Polar Region’ (1861); etc.

Richardson, Leander, American journalist: b. Cincinnati 28 Feb. 1856. He has been engaged on various leading newspapers, was editor of the ‘Dramatic News’ in 1891–6, on the editorial staff of the New York *Morning Telegraph* 1896–1900, and is now (1906) editor of the ‘New York *Inquirer*.’ He has adapted several plays and operettas from the French and has written: ‘The Dark City’; ‘As Ye Sow’; the plays: ‘The Millionaire’; ‘Under City Lamps’; etc.

Richardson, Rufus Byam, American archæologist: b. Westford, Mass., 18 April 1845. He was graduated from Yale in 1869, studied divinity at Yale 1869–72, and at Berlin 1872–74. He was professor of Greek at the University of Indiana 1880–2, and at Dartmouth 1882–93, and since the year last named has been director of the American School of Classical Studies at Athens, Greece. He has edited Æschines' ‘Oration Against Ctesiphon’ (1889); and contributed frequently to the ‘American Journal of Archæology’ (1892–1902). He wrote ‘Vacation Days in Greece’ (1903).

Richardson, Samuel, English novelist: b. Derbyshire, 1689; d. Parson's Green, near London, 4 July 1761. Up to the age of 50 the life of Richardson was not only uneventful, but undistinguished. The son of a joiner of the better class, who had moved from London owing to circumstances vaguely connected with Monmouth's rebellion, there is no clear evidence that he ever had more than what he calls “common school learning.” His father's means did not permit him to take orders, but as a concession to an early taste for reading, he was, when the family returned to the metropolis, apprenticed to John Wilde, an Aldersgate street printer. Here he exhibited the usual traits of the exemplary apprentice; proceeded, in due course, compositor, corrector, overseer, and master; and, as in duty bound, eventually married his employer's daughter. From Fleet street, where he first began business, he moved to Salisbury Court (now square); set up newspapers and books; worked on the publications of the Society for the Encouragement of Learning; and advanced generally in an industrious career. His first wife dying in 1731, he married again, his second wife being the sister of James Leake, a Bath bookseller. Children were borne to him by both his wives; but he was well past middle life before he had acquired any literary reputation, although he had long been known to his friends as what Goldsmith calls “a dab at an index,” a clever compiler of opportune prefaces and “honest dedications,” and, above all, a copious and indefatigable letter-writer.

This, from his childhood, had been his hobby. As a boy he was the chartered secretary of all the love-sick girls in the neighborhood; as a printer's apprentice he had corresponded voluminously with a gentleman who was a “master of the epistolary style;” and it is characteristic of the qualities he afterward developed as a novelist, that his communications were always of the moral or improving order. Out of these things arose his first literary effort. Two bookseller friends, Rivington and Osborn, suggested to him the preparation of a model letter-writer. Richardson at once went farther by proposing that the letters should teach those concerned to think as well as write. Such was the origin of the little-known volume of ‘Familiar Letters’ issued in January, 1741. Before it was finished, one of the model epistles, coupled with the recollection of something he had heard some 20 years before, led him to the composition of a story, also in letters, dealing with the triumphs of chastity in humble life. The idea rapidly grew into the famous ‘Pamela; or, Virtue Rewarded’ (1740), which not only obtained an immediate and unexampled success, but, by superadding to the patient realism of Defoe a power of minute mental analysis which Defoe did not possess, set a new fashion in fiction. It is this latter quality, together with the transfer of the fable from the impossible land of heroic romance to the very probable region of ordinary life, which gives the Salisbury Court printer his claim to have invented the novel of sentimental analysis as opposed to the novel of manners. Despite the moral professions of ‘Pamela’ many of its scenes are needlessly indelicate; and the final union of the heroine to the man who has repeatedly attempted her ruin is unpleasant,— to say nothing of the fact that there is a sordid air of calculation about the virtue she so vigilantly preserves. But dealing, as the story did, with real people in a real way, in what was, moreover, a dead season of letters, the book's success is not surprising. Fine ladies raved about it in public places. Clergymen praised it from the pulpit. Pope, sincerely or insincerely, declared it “would do more good than many volumes of sermons,» and the voices of the continuer and parodist were speedily heard in the land.

Of the inevitable sequel, ‘Pamela's Conduct in High Life,’ by John Kelly of the ‘Universal Spectator,’ nothing need be said, save that it forced Richardson upon a continuation of his own, now deservedly neglected. But among the numerous publications prompted by ‘Pamela's’ more assailable side, two in particular require to be mentioned. One was ‘An Apology for the Life of Mrs. Shamela Andrews,’ a clever but very gross attack upon the inner morality of the heroine. Richardson himself attributed this to Fielding, as did other of his contemporaries; but Fielding is never known to have acknowledged it. Ten months later Fielding issued ‘Joseph Andrews,’ which at all events set out with the open intention of burlesquing Richardson, although its writer promptly abandoned this inadequate motive with the development of more important characters than Pamela Booby, a name which, both in ‘Shamela’ and ‘Joseph Andrews,’ is cruelly filled in from Richardson's hero, «Mr. B.» Either of these performances was sufficient to be a thorn in the side of ‘Pamela's’ sensitive author. But probably the worst thorn of all was the success of Fielding's ‘Tom Jones,’ which appeared not long after Richardson's next novel of ‘Clarissa.’

‘Clarissa; or the History of a Young Lady,’ usually misnamed ‘Clarissa Harlowe,’ was published in 1747–8, in seven volumes and three instalments. The story, which deals with the «Distresses that may attend the Misconduct both of Parents and Children in Relation to Marriage,» is an intensely tragic one. The heroine, a very pure and beautiful woman, is deliberately hunted down by a relentless seducer, whose eventual death at the hand of her guardian only faintly satisfies poetical justice. But in this book Richardson rises to the height of his powers. Encumbered by a story to be told in letters, and trammelled with his own prolixity, he nevertheless contrives to hold his readers fascinated, not only with the fortunes of his heroine, but with the individuality of her despicable but dazzling pursuer, who is drawn with surpassing dexterity. The intermittent mode of publication added flame to the public interest in the issue; and the writer was bombarded with appeals for a «happy ending.» As to this, he showed more artistic fortitude than might have been expected. Imperfect as his education had been, he had learned from the ‘Spectator’ that to «make virtue and innocence happy and successful» was to defeat one of the great ends of tragedy, «the raising of commiseration and terror in the minds of the audience.» So Clarissa Harlowe dies elaborately of a broken heart; and her history remains a masterpiece.

By this time Richardson was nearing 60, and might reasonably have held his hand. But the welcome accorded to Fielding's ‘Tom Jones,’ coupled with the importunities of his coterie of lady friends, soon engaged him in a third effort, the object of which was to delineate a model good man and fine gentleman combined. This was the ‘History of Sir Charles Grandison’ (1753–4), a book which still has its admirers, though it does not by any means attain the tragic level of ‘Clarissa.’ That the hero of such a work should be something of a prig is inevitable; but he has many estimable qualities which are not ridiculous; and he is surrounded by a bevy of female worshippers who are drawn with unquestionable skill. Neither Clementina nor Harriet Byron could have been conceived by an inferior artist. It is easy to make fun of the little printer's superexcellent central figure; but there must, in spite of his long-windedness, have been something in the personage who could attract the admiration of both Ruskin and the Master of Balliol.

Beyond a very popular paper in Johnson's ‘Rambler,’ Richardson wrote nothing more of importance. He continued to prosper in his business, made money, became Master of the Stationers' Company, and eventually Law Printer to the King. He was a nervous, inoffensive, sensitive valetudinarian, delighting in the stimulus of feminine adulation rather than in the robust criticism of his own sex. His style is hopelessly pedestrian and diffuse; but it has an extraordinary cumulative power which attracts, and by degrees detains, the persevering reader. His faculty of minute imagination is wonderful; and he gradually acquired an extraordinary insight into the workings of the female heart. The English fiction which followed developed itself on somewhat different lines; but it is impossible to deny to him the credit of inaugurating the novel of sentimental analysis, which for a time became the fashion, even more in France and Germany than in England.

Bibliography.— Richardson's life has been written by Mrs. A. L. Barbauld, ‘Memoir’ prefixed to ‘Correspondence’ (6 vols., 1804); by Miss C. L. Thomson (1900), and by Austin Dobson, ‘English Men of Letters’ (1902). Consult also Scott's ‘Lives of the Novelists’ (1825); Mrs. Oliphant, ‘Blackwood's Magazine’ (March, 1869); H. D. Traill, ‘Contemporary Review’ (October, 1883), and Texte's ‘Jean Jacques Rousseau’ etc. (1895). There are editions of his novels by Rev. E. Mangin (1811); Sir Leslie Stephen (1883); Mrs. McKenna (1901), and Prof. W. L. Phelps of Yale. There are several portraits of Richardson by the painter Joseph Highmore.

Austin Dobson,
Author of ‘Life of Richardson,’ etc.

Richelieu, Armand Jean du Plessis, ärmän zhŏn dü plĕs-sē rēsh-lē-e, Eng. rēsh'loo, **Cardinal**, Duc de, French prelate and statesman: b. Paris, according to Jal, who cites a register of baptism, 9, not as usually stated, 5 Sept. 1585; d. Paris 4 Dec. 1642. He was originally destined for the profession of arms but his brother, Alphonse, having resigned the bishopric of Luçon, this was bestowed on him by Henry IV. (1606). He obtained from the pope a dispensation allowing him to accept the office though under age, and on 16 April 1607 was consecrated by the Cardinal de Givry in presence of the pope himself (Paul V.). For several years he devoted himself to the duties of his see, reforming abuses, and laboring for the conversion of Protestants. But his ambition always made him turn his eyes toward the court, and having come to Paris in 1614 as deputy of the clergy of Poitou to the States-General he managed to insinuate himself into the favor of the queen-mother, who obtained for him the post of grand-almoner, and in 1616 that of secretary of state for war and foreign affairs. On the disgrace of the queen-mother (1617) Richelieu fell with her, and was banished first to Blois and then to Avignon. In 1620 he managed to effect a reconciliation between Mary of Medici and her son Louis XIII. On 5 Sept. 1622 he obtained through her influence the cardinal's hat, and on 19 April 1624 was admitted into the council of state. No sooner was Richelieu secure in his high post than he began systematically to extend the power of the crown by crushing the Huguenots and overthrowing the privileges of the great vassals, and to increase the influence of the French monarchy by undermining that of the Hapsburgs, both beyond the Pyrenees and in Germany. Louis XIII., sensible of the energy of his minister, favored his plans, though he always showed a dislike for the man, whom he would gladly have destroyed had he been able to govern without him. The Huguenots had for a long time resisted the royal power; and bloody insurrections, in several preceding reigns, had arisen from their struggles in their attempts to gain political and religious power. The wisdom and mildness of Henry IV. had, indeed, assuaged the excitement of the contending parties, but his reign was too short to extinguish the fires. Richelieu resolved to crush the weaker by the aid of the stronger party, and thus to deprive those who should be disposed to resist his schemes of their main prop. The rallying-point of the Huguenots was Rochelle; and Richelieu neglected no means to make himself master of that city. In the celebrated siege of Rochelle he commanded the army in person.

Rochelle, supported by England, from which it continually received supplies, held out for a long time against all the efforts of the cardinal; and the hope of reducing it was already nearly abandoned, when Richelieu, by the erection of an immense mole, cut off the communication by sea, and finally compelled it to surrender by famine (1628). It would be a mistake to see in this war that Richelieu waged against the Huguenots an example of religious intolerance, for although this would have been quite in keeping with the spirit of his time, Richelieu was, with respect to this matter, in advance of his age. He destroyed the political consequence of the Huguenots as a separate body within the state, but by the Peace of Alais or Edict of Grace, which concluded the war (June 1629), he left them liberty of worship and equality of civil rights, and throughout his ministry employed them, with other citizens, in the army, the magistracy, and offices connected with the revenue. During the continuance of this war Richelieu had taken various steps in pursuance of the other main end of his internal policy, the overthrow of the power of the great nobles. In 1626 he ordered the demolition of all those feudal fortresses which could not be used for the defense of the frontiers, and which were a perpetual menace to the crown. The next step was the removal from court of the queen-mother who had become hostile, and endeavored to obtain Richelieu's downfall. Saint Simon represented to the king the services of Richelieu and the impossibility of dispensing with his aid. Louis, therefore, ordered him to Versailles, and assigned him apartments in the palace directly below his own. This day (10 Nov. 1630), on which the hopes of the queen and of the cardinal's enemies were disappointed, was called the «Day of the Dupes» («la Journée des Dupes»). The queen-mother was banished to Compiègne, her friends removed from place, and some of them thrown into the Bastille. This step, and the almost total annihilation of the privileges of the parliaments and the clergy, excited all classes against the despotic administration of the cardinal, and the discontent broke out in numerous risings and conspiracies, which, however, were not only suppressed by the prudence and vigor of his measures, but also contributed to the furtherance of his plans, and gradually rendered the royal power entirely absolute. In 1632 the royal arms, directed by Richelieu (in the previous year raised to the rank of duke), suppressed the rising in favor of the Duke of Orleans, the king's brother, to which the Duke of Montmorency had been induced to lend his support. Even those whom the king privately favored were obliged to yield to the all-powerful minister, and paid with their lives for their rashness in venturing to oppose him, as in the instance of Cinq-Mars, who in 1642, had entered into a conspiracy against him, which the king was, not without reason, believed to have favored. While the minister was thus extending the power of the crown at home he did not neglect the aggrandizement of the monarchy abroad. The Thirty Years' war gave him an opportunity of effecting this object. The same man who pursued, with the greatest severity, the Protestants in France, employed all the arts of negotiation, and even force of arms, to protect the same sect in Germany, for the purpose of humbling the house of Austria. In the early stages of the war he subsidized Count Mansfeld. Subsequently Gustavus Adolphus, king of Sweden, the great bulwark of religious liberty in Germany, received aid of every kind from Richelieu as long as he was not in danger of becoming formidable to France; but when the brilliant victories of Gustavus gave the cardinal reason to consider his power as more dangerous than that of Austria he abandoned that prince in the midst of his successes. The war which he undertook against Spain, and which continued till 1659, put France in possession of Catalonia and Roussillon, and the separation of Portugal from Spain was effected by his assistance (1640).

Richelieu must be allowed to have deserved the character of a great statesman; he cannot be denied the glory of having raised the power of the sovereign in France to its highest pitch; but he was proud, arrogant, and vindictive. He was a patron of letters and art, and founder of the French Academy and the Jardin des Plantes. Louis XIII. died a few months after him; but in the long reign of Louis XIV. the effects of Richelieu's policy were yet visible. Richelieu was the putative author of ‹Mémoires› relating to the years 1632–5; ‹Maximes d'Etat ou Testament Politique du Cardinal de Richelieu›; and ‹Journal du Cardinal de Richelieu.› The first two are doubtful, the last spurious.

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